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THE VARIATION OF INSECTS.

BY T. D. A. COCKERELL, BOULDER, COLORADO.

Nearly thirty years ago English entomologists began to take a new interest in the variation of Lepidoptera, and in the interval since that time, principally owing to the activities of J. W. Tutt, a very large amount of detailed information has accumulated. Tutt's "British Noctuæ and Their Varieties," in four volumes (1891–1892), deserves to rank as a classic, although at the time of its publication it was received by many with something less than enthusiasm. More recently, the great monograph of the British Lepidoptera, left unfinished owing to Tutt's untimely death, covered the subject of variation in an exhaustive manner, including all phases of the species treated, whether British or foreign. In its exhaustive character, this work runs parallel with Taylor's Monograph of the Land and Fresh-water Mollusca of the British Islands, still in course of publication. The variation of Lepidoptera also receives very full treatment in "The Macrolepidoptera of the World," edited by Dr. Adalbert Seitz, and published in English, French and German. This series of volumes, although planned and published in Germany, is thoroughly international in its character, a large part being written by English entomologists. The volume on the Palæarctic Noctuidæ, for example, is the work of W. Warren. During the war publication has ceased, and I do not know whether it will be continued.

To those who had been concerned primarily with the study of genera and species, all this minute attention to variation seemed rather like counting pebbles on the beach. Let us assume, they said, that all species are variable, and state the facts in general terms. It may be well enough to record varieties, but why give them names? Will not the whole subject be buried in a complex nomenclature? It is, of course, quite true that when one is dealing with a large and little known fauna, the species problem is sufficient to tax one's energies; and, as a rule, the material at hand is not adequate for a study of variation. It is only when the species are fairly well known, and large series of specimens have accumulated, that such methods as those of Tutt become possible or advisable. When, however, the time has come for intensive study, it must be insisted that the records should be exact, and that all looseness of expression should be avoided as far as possible. It is found, in practice, that the only way to avoid ambiguity is to name and define the principal forms, which then become standards for comparison. The literature is full of statements concerning "melanic" or "albinic" or otherwise modified forms, which are so ambiguously referred to that it is impossible to be sure what was intended. Moreover, the adequate taxonomic treatment of the subject gives us a summary of what is known, properly arranged and made intelligible.

While the descriptive side of the study of variation has occupied the attention of many workers, others have taken up the subject for the experimental

side, with results of extraordinary interest, not only to entomologists, but to all biologists. In the earlier days Weismann and Merrifield, in later times such men as Standfuss of Zurich and Morgan of New York, have produced works of such value as to arrest the attention of all naturalists. In particular, Morgan's intensive study of the vinegar-fly, *Drosophila*, has given us a knowledge of the facts of variation and heredity which the most optimistic would have declared impossible a few years ago. Thus all doubt as to the value of minute and detailed investigation of single genera and species has been dispelled, except in the minds of those who take no interest in the biological problems of the day. Indeed, it must be said that any able student who will study a single small group or species from *all points of view*, will be sure to get results of value and importance, whereas as a collector of miscellanea he may go through life without making any significant contribution to science. Thus the new outlook and the new methods open up a great new field for amateurs, who may readily make themselves more familiar than any one else with a special small field of research, knowing at the same time that their discoveries will have some bearing on the whole structure of biological science.

We approach the subject of variation to-day with many advantages not enjoyed by our predecessors. Owing to the rediscovery of Mendel's work, and the great advances in our knowledge of eytology and of the processes of heredity, we are able to interpret what we find with better success. We no longer content ourselves with describing, in objective terms, the phases of variation found, but undertake to classify them according to their true dynamic significance.

Variation may arise from different causes, as follows:

1. Original variation, due to some change in the character of the germ plasm itself. Theoretically, this may come about either through (a) the addition of something, or (b) the subtraction of something, or (c) the redistribution of what was already there, following the phenomena already well known to students of organic chemistry. Tower, of Chicago, appears to have produced variations of this sort in potato-beetles (*Leptinotarsa*), but it is possible to interpret them as the result of selective destruction of elements (genes) in the germ plasm, which is, at least theoretically, a different matter from altering the genes (factors determining characters) themselves. The sudden appearance of red on the rays of a sunflower in Colorado can be interpreted as due to a doubling-up or duplication of a gene for red which is undoubtedly present in the normal wild plant.

   Furthermore, when a variation occurs in a gamete (unfertilized germ cell) which is recessive to the normal,—that is, fails to produce any effect when united with a normal gamete,—it may be an indefinite time, possibly a thousand years, before there will be any visible result. A visible result will only appear when two individuals, each carrying the modified character, chance to mate. Thus when we witness what appears to be an entirely new "break," we may be observing the consequences of a chemical change which occurred long ago, the causes of which, whatever they were, have long ceased to operate.

   The most important evidence has been obtained by Professor Morgan and his associates in their studies of *Drosophila*. In numerous cases new variations have arisen under circumstances which seem to

indicate without question the mutation of factors or elements in the germ-plasma.

2. Variation due to new combinations, or to recombinations of genes normally carried by a species (as in sex-dimorphism, polymorphism, etc.). This is the kind of variation we are most familiar with, and which has been the subject of so much experimental research. Not only may genes or determiners be shuffled in inheritance, as Mendel described, but those constantly present may be greatly modified by the unexpected appearance of others, which have until then escaped notice. Thus in the sunflower there is a series of pattern-factors, which only become evident when the factor for red rays enters the combination.

   In the case of the many mutants of *Drosophila* observed by Morgan, all within the limits of a single species, it is difficult to resist the conclusion that a process of subtraction is going on under our eyes, leaving combinations which are new in the sense of lacking some of the original elements. In other analogous cases, we are struck by the fact that the *same kinds* of subtractions occur in many different genera and species, showing that the tendency to perform these tricks is deep-seated in the protoplasm of the whole race. There is here involved a question which cannot be said to be settled, and to which much additional research must be directed.

3. Variation due to the direct action of the environment, which, as we have learned from Weismann, is not inherited. Nevertheless, the power to react to the environment in particular ways *is* inherited, and hence even these variations cannot be dissociated from the question of heredity.

On the negative side, as it were, we have the facts of palæontology. The study of fossil insects shows us that many apparently trivial characters, such as the arrangements of spots on wings, are of enormous antiquity. Not only this, but as Wheeler's researches on the ants of Baltic amber have shown, specialized habits and reactions are likewise millions of years old. It, therefore, becomes more probable that the phenomena of variation which we witness to-day represent, mainly at least, the shuffling of very ancient cards.

In the Canadian fauna, there are several notably attractive opportunities for the study of variation. I will refer now only to a single family of insects, with which I have been especially concerned in recent years; the Saturniidæ. The publication of Packard's Monograph (Memoirs National Academy of Sciences, vol. XII) brings the subject fairly up to date, and makes it convenient to go forward from the point there attained. The genus *Samia*, as represented in Canada, is extremely interesting. There is not only the question of the relationships of the species *cecropia*, *gloveri*, *columbia* and *rubra*, but *columbia* has in the west a remarkable race *nokomis* (Brodie), while *rubra* produces at Kaslo a form *kasloensis* Ckll. These are merely conspicuous outstanding facts; large collections from many localities, together with experimental breeding, will bring out innumerable details of interest. Another very interesting species is *Telea polyphemus*, the variations of which should be studied exhaustively, and compared with those of the great Asiatic silk-moths. The Hemileucidæ, also included in Packard's book, afford similar opportunities, and owing to their smaller size are somewhat more manageable.

NOTES ON THE CANADIAN REPRESENTATIVES OF BRITISH SPECIES OF BEES.

BY F. W. L. SLADEN, APIARIST, DOMINION EXPERIMENTAL FARMS.

Of the twenty-eight genera of bees given in Saunders' "Hymenoptera Aculeata of the British Isles," no less than twenty-two occur in Canada. The six absent are small genera belonging to an ill-defined unimportant complex in the *Andrena* group, several of which may yet be found to exist in Canada when this large genus, full of raw material, has been analyzed. In most of the genera common to both countries, there are many Canadian species which are more or less closely related to British species. The following are a few outstanding examples:

Colletes cunicularia Linn.

Colletes inæqualis Say, by far the largest species of *Colletes* in Eastern Canada and the only one occurring in spring, is apparently the representative of *C. cunicularia* Linn., also much the largest species and the only spring one found in England. Both are among the earliest bees to appear in spring. Ottawa specimens differ from British in having a much shorter coat, which is generally paler and greyer (less brown), and they have well-developed bands of white felt* on the margin of each segment of the abdomen. These bands in British specimens are scarcely discernible, being composed of fewer, looser hairs, which are dingy. Ottawa specimens are smaller; several females measured averaged in length 13.33 mm.; British females 14.00 mm.; Ottawa males 11.00 mm.; British males 13.25 mm.

Andrena clarkella Kirby.

Comparison of a male and two females of *Andrena bicolor* Prov. taken by the writer at Ottawa, and a female from Abitibi, with two males and two females of *A. clarkella* Kirby, taken at Maidstone, Kent, England, and with Saunders' description of this species shows no differences either in structure or colour. Even the tint and extent of the different hair colours in both sexes are identical. The characteristic red and red-haired hind tibiæ and tarsi, and black-haired notum in the female, and the comparative lengths of the antennal joints 3, 4 and 5 in both sexes are the same. The Canadian examples however, are a little smaller:—females, average length 12.00 mm.; Maidstone females 12.75 mm.; Ottawa males 8.75 mm.; Maidstone males 9.75 mm.; and the coat on the thorax and abdomen is much shorter and less shaggy in the Canadian specimens. In both countries these are early spring bees. The Ottawa females were taken during early willow-bloom on April 25, 1915, about ten days after the snow had gone, and the male on April 27. In England it is taken in early March and has been recorded as early as February 19. It is also widely distributed northwards and uncommon, both in Canada and England.

Andrena wilkella Kirby.

Andrena winkleyi Vier. is the same as *A. wilkella* Kirby. I can find no differences in structure or size. Both are abundant in late spring at Ottawa and Dover respectively, and are fond of the same plants; *Myosotis*, etc. In both, the third antennal joint is shorter than the fourth, a character by which *wilkella*

*The word "felt" is used to describe very short, close hair, the individual hairs of which are thicker than ordinary hairs. Felt grades into ordinary hairs.

is known from its close ally *similis* Sm. This is a short-haired species in which white felt bands on the abdominal segments are well developed with a corresponding bare area on the disc of the segment.

Osmia fulviventris L.

Specimens of both sexes of *Osmia purpurea* Cr. from Ottawa and Toronto agree in every respect, including size, with those of *O. fulviventris* L. from Dover. This is, therefore, a parallel case to that of *Andrena wilkella*, and it is perhaps worthy of note that the *Osmia* appears in late spring after most of the other species of its genus have appeared as in the case of *A. wilkella*.

Megachile ligniseca L.

Comparison of both sexes of *Megachile inermis* Prov. (*M. decipiens* Lovell and Cockerell) taken at Ottawa, shows this species to be closely related to *M. ligniseca* L. of Europe. Prominent characters possessed in common by specimens from Dover and from different parts of Canada are the very short, decumbent black hair on the disc of the sixth segment of the abdomen and the large head in the female. But the white felt bands on the margins of the segments of the abdomen, well marked in Canadian specimens are rudimentary in the British specimens. Canadian specimens also differ in having the pollen collecting-brush cream coloured—not reddish, and the body hairs grey and black—not brown, and the coat distinctly shorter. Ottawa specimens are also smaller, average length of Ottawa females 14.33 mm.; Dover females 16.00 mm.; Ottawa males 12.61 mm.; Dover males 13.88 mm. Specimens have been bred in this country from a rotting piece of an apple tree found by Prof. Arthur Wiley at McGill College. In England it burrows in wood that is more or less decayed. Most of the other *Megachile* burrow in the ground.

The same differences,—shorter coat, which is whiter (less brown) with stronger white felt bands, and paler (less red) pollen brush, separate *M. vidua* Sm., a species common all over Canada from *M. willughbiella* Kirby, a species common in England and Northern Europe.

Anthophora furcata Pz.

This British bee is represented in the American fauna by a bee known by the name of *Clisodon terminalis* Cr., which occurs in Canada from coast to coast and at least as far north as Cochrane, Ont. and Edmonton, Alta. Friese gives the range of *A. furcata* in Eurasia from Norway to Mongolia and south to Caucasia. Ontario specimens differ from British in both sexes in having a shorter coat—much shorter and scantier on the abdomen of the female and generally less brown but greyer and paler, and the hairs on the abdomen run into dense pale bands on the margins of the segments, taking, in the female the extreme form of narrow bands of white felt, interrupted in the middle. No tendency to white felt bands is noticeable in the specimens from Dover. Saunders even gives this as a character for the species. The white felt bands are also absent in four females from the Pacific Coast, (Agassiz, B. C., Shawnigan Lake, V. I., and Victoria, V. I.) but they may have been rubbed off.

Specimens from Ottawa are distinctly smaller than specimens from Dover, but the females from the Pacific Coast are even larger than British females as shown in the following table, and they probably represent a distinct species or at least a geographical variety to which the name *neofurcata* is here given.

7 Ottawa males average length 9.50 mm.
7 Ottawa females average 10.75 mm.
5 Dover males average length 10.70 mm.
5 Dover females average length 12.80 mm.
4 Pacific Coast females average length 14 mm.

In England, *Anthophora furcata* is very faithful to its food plant, *Stachys sylvatica*, and the Canadian forms may always be found on *Stachys palustris*. Saunders notes that it burrows in "dead wood," although other species of the genus burrows in the ground. Attracted by a heap of white sawdust around a decayed but still hard stump near Hull, P. Q., on August 16th, 1913, I found this to be riddled with the burrows of *Clisodon terminalis*. The exceedingly active females, resembling honey-bees in appearance and size, passed in and out of numerous holes in the stump as frequently as the workers of a strong colony of bumble-bees.

Bombus and **Psithyrus.**

These northern genera, so rich in biological material, furnish an interesting contribution to this study. They never develop felt bands but there is a uniform coat of long hair resembling fur.

Bombus borealis Kirby.*

Bombus borealis Kirby, fairly common and widely distributed in the boreal region of Canada east of the Rocky Mountains has its British representative in *B. distinguendus* Morawitz, the distribution of which, according to Hoffer, extends to Siberia. Here again the pattern and even the tint of the coat, deep greenish yellow with a black band across the thorax, very variable in most species of *Bombus*, is common to both forms with the unimportant exception of more or less black hair on the last segment of *borealis*, but the British specimens are larger (average length of females 20 mm. compared to 18 mm. in *borealis*) and they have a much longer and more uneven coat.

In the Mountains and Pacific Coast region, *borealis* is replaced by a form, *appositus*, that is intermediate in size between British *distinguendus* and *borealis*, having a coat slightly longer than *borealis* and the yellow band on the anterior part of the thorax very pale while there are no black hairs on the abdomen. *Appositus* is evidently still more closely related to *distinguendus* than is *borealis*. In both the Old and New Worlds, the queens of all these forms appear later in the spring than those of almost every other species of *Bombus*. The colonies consist of comparatively few workers, and the young queens and drones are raised early. The period of activity therefore lasts a shorter time than in the case of the other species.

Bombus terrestris L.

One of the commonest and most aggressive species of *Bombus* in England and the continent of Europe is *terrestris L.* This is represented in Canada from the Atlantic Coast to the Mountains by an equally common and aggressive species, *B. terricola*. In habits, *terricola* agrees with *terrestris* not only in those common to the *terrestris* group such as biting holes at the bases of flowers, but also in the unique habit that separates *terrestris* from its close ally in England, *lucorum*, of continuing to leave its winter quarters in small numbers from the opening of spring right on until about mid-July when all other species have

*This name has priority over *distinguendus*.

ceased to appear, instead of during the shorter and more definite period common to all the other species of *Bombus*. *Terricola* has the tip of the abdomen tawny like many *terrestris* forms. In *lucorum* forms, however, this remains always white. *Terricola*, however, has a much wider yellow band on the abdomen than any Old World form of *terrestris*. In this respect it converges towards other species of *Bombus* found within its region, *fervidus*, *borealis*, etc., *Terricola* has the coat much shorter than *terrestris*. It is also smaller, average length of female *terricola* 18 mm., female *terrestris*, from Dover, 20 mm.

B. terricola is replaced in the Mountains and on the Pacific coast by the closely related *occidentalis*, a somewhat longer-coated species. I do not think that *terricola* and *occidentalis* intergrade because I have taken both forms at Banff, Alta.

Bombus lucorum L.

Bombus lucorum, above mentioned, is, in Britain and Europe, a small mountain or northern form with a rather long coat. *B. moderatus* Cr. a species of the *terrestris* group with colour pattern the same as that of *lucorum*, is found at Banff, Alta. and in Northern B. C., Yukon Territory, and Alaska. It undoubtedly is a *lucorum* form. It differs from *lucorum* only in the somewhat paler tint of its yellow bands. In this respect, it not only follows *appositus* of the same region, but approaches *albocinctus* Sm. the *lucorum* form found in Kamchatka, Siberia, which has these bands white.

Bombus lapponicus Fab.

Franklin notes the close relation between *Bombus melanopygus* Nyl., a very long-haired, red-banded species, common in the Mountains and Pacific Coast region and *Bombus lapponicus* Zett. a species found on the high moors of the north of England and Scotland and in arctic and sub-arctic Europe. *Sylvicola* Kirby, from Arctic Canada, of which *melanopygus* is probably a variety, seems identical with *lapponicus*.

Psithyrus vestalis *Fourc.*

Bombus terrestris is preyed upon in England by *Psithyrus vestalis* Fourc. A *vestalis* form known as *ashtoni* Cr. is found throughout the range of *B. terricola* and is probably parasitic on it. *Ashtoni* is smaller than *vestalis* and has a shorter and paler coat.

Apis mellifera L.

The variety of honey-bee native to Britain has an entirely black tegument, dark brown hair and feebly-developed white felt bands on the margins of the segments. This variety is native to the whole of Western Europe, and it has been introduced into and has spread through Canada during the last two or three hundred years. It still predominates in the Gulf Region, in the north, and on the Pacific Coast. But in Southern Ontario and on the Prairie, it has been largely replaced by the Italian bee, introduced about fifty years ago from Southern Europe, which has the tegument of the abdomen banded with orange, has paler hair and well-developed white felt bands. This bee is also slightly smaller than the black bee. The honey-bees of the Prairie show great constancy in the strong development of the white felt bands.

CONCLUSIONS.

1. The bee fauna of the boreal zone of America contains a number of species closely related to, and in some cases indistinguishable from those in

north-western Europe and furnishes evidence of a former land connection with a climate comparable to that of Britain or Ontario, in which these species lived.

2. There are, however, in a number of cases certain more or less pronounced differences in character between the descendants now living in Britain and Canada. As a rule, the Canadian forms are smaller, and they have a shorter, closer, less shaggy coat, the colour of which is not so rich or deep, but paler, more dingy; brown changes to ashy grey or dingy white, and red to orange or cream. Usually in the genera where white felt bands are liable to occur on the abdominal segments, these bands either appear for the first time in Canadian forms, or are better developed, that is to say, are wider and more extensive as well as of a more extreme type, with a corresponding reduction of hair on the disc of the segment. Melanism is less frequent and less pronounced. These differences are so widely spread that they evidently represent a definite principle.

3. Searching for the cause of these differences we find there is an approach towards the British type of characters on the Pacific Coast and in the north of Canada where the summer climate is cool as in Britain, and they are most departed from in the interior and southern part where it is warm. A good illustration of this, in addition to those already given, is found in *Megachile perihirta*, Ckll. a species that has no Old World representative. At Lethbridge and in the Kootenays, this species has definite white felt bands on the margins of the abdominal segments and there are no black hairs amongst the pale ones on the apical segment. At Victoria, B. C., the white felt bands are weaker and partly broken, the hairs composing them being longer and less dense, and the whole coat is slightly longer. At Cochrane in Northern Ontario these bands are still weaker and the hair on the apical segment is black.

All the species of *Bombus* occurring on the Pacific Coast, in the mountains of B. C. and in the Arctic, have a longer, shaggier coat than those occurring in Ontario. The species of *Bombus* that has the most southerly range in Canada, *B. pennsylvanicus* has the shortest coat of all. Species of *Bombus* in the Shetland Islands are rather larger and have longer, shaggier coats than the same species in Scotland. In Great Britain and in Canada also, not only are the species having longer and shaggier coats more plentiful in the north and west, but the shorter-coated species, if they extend so far, grow longer coats.

For the same or closely related species, size tends to become as a rule, smaller in the south and interior, but the south-interior contains many species, not found all over, some of which are of giant size.

In Canada, the interior and southern conditions reach their extreme at Medicine Hat, a dry, hot, basin-shaped locality in Southern Alberta. Here the species of *Anthophora* belonging to the subgenus *Amegilla*, characterized by an extreme development of the white felt bands and swift flight, are common. Species of *Amegilla* are numerous in Turkistan, Central Asia. At Medicine Hat species of *Halictus*, *Colletes*, *Melissodes* and *Melecta* appear that are almost covered with dust-like felt. Amongst the parasitic bees, *Coelioxys ribis* Ckll. is common throughout Canada. In Southern Alberta is found a small form of this species known as *grindeliæ* Ckll. (average length of female 10.33 mm. compared with 11.66 mm. of *ribis*). In *grindeliæ* not only are the white felt bands on the abdomen much wider, but the face is largely covered with white felt, and the white hair on the sides of the thorax inclines towards felt. At

Medicine Hat, too, a general change in tegmental colour, which must not be confounded with hair colour, is noticeable. Yellow bands and markings in the bare or nearly bare bees and wasps expand and multiply at the expense of black, and species, often of giant size, having red markings, especially on the first segment of the abdomen begin to appear, notably in the bee genera *Anthidium*, *Epeolus* and *Nomada*, and in the wasp genera, *Vespa*, *Bembix*, *Microbembex*, (yellow); *Philanthus*, *Cerceris* and *Odynerus* (red markings). Several species of *Andrena* from Toronto and Winnipeg regions have a red abdomen, but on the coasts and in the North the abdomen is always black. At Oxford, England, *Andrena hattorfiana* has a red abdomen, but at Dover the abdomen of this species is black.

Reduction of humidity acts in the same way as heat, but it appears to be less important. Indeed, in the present study, it can be demonstrated to be a negligible factor if rainfall be taken as its criterion. The summer rainfall of Dover and Victoria, B. C., is much less than that of Ottawa and Toronto. But humidity cannot be judged by rainfall which increases the relative humidity of soil and air in our region much less than heat reduces it.

Differences in winter temperature and rainfall, however, do not affect the characters to any extent. The same varieties are found on the mild and wet Pacific Coast as on the dry cold mountains. This is the more remarkable when when we remember that the distribution of the plants on which the bees feed is greatly affected by winter climate.

The same differences that are found between bees in a cool coastal summer climate and a warm interior one, are found between spring and summer flying bees in the same climate, and they are more marked in regions like Britain and the Pacific Coast where the spring is cool, than the interior of Canada where it warms up quickly. In England, and to a less extent in Ontario, the one species of *Colletes* that flies in the spring is larger and has a longer coat with feebler felt bands than the many species that fly in summer. Similarly, the early spring flying species of *Andrena* are large, have long coats and no felt bands; the summer flying species are generally smaller (except giant southern forms), have shorter coats with bare areas and frequently felt bands. At Ottawa, *A. cockerelli* which appears in spring before the snow has gone, has a longer, shaggier coat with less tendency to bare areas than any other species in Eastern Canada. Britain and the Pacific Coast have several large, robust, shaggy and long haired species of *Anthophora* appearing in early spring as well as shorter haired summer species, but the long haired spring species are not found on the prairie or in Eastern Canada.

Many of the differences noted are more shown in the females than in the males. Abdominal felt bands are always better developed in the females than in the males. Females of numerous species develop red tegumental markings, while the males remain black or yellow. In many species of *Sphecodes* the abdomen is black in the male and red in the female. In a large wasp found in Medicine Hat, Alta., *Eucerceris gloriosa*, the male is yellow and the female red. In *Vespa carolina*, a species found at Point Pelee, Ont., by Mr. Taverner, the queen has orange markings, while in the workers these markings are yellow. Can the reason be that the female has a longer adult existence, or that the continuance of the species depends solely upon it after the male has died?

Do the cool and warm conditions during the flying season work their opposing effects on the adult or the larva, or both? The female *Halicti* pass the winter as adults, but live on until summer when they raise their brood. They have short coats and are of small size. The honey-bee raises its brood and passes the night in activity under the conditions of all seasons in an artificial heat provided by the colony. The European species of *Andrena*, *A. gwynana* Kirb. has two broods in the season. The spring-flying adults raised the previous summer hibernate as adults and are more robust with longer coats than the summer flying adults which are raised in the spring and have the slender, feeble appearance of the few species of *Andrena* found in the tropics.

Queens of the Italian bee that have been chilled in the pupa stage have the orange part of the integument darkened, and queens of *Bombus lapidarius* L. that slowly passed the pupa stage in the lowest temperature that could support life, had their black and red coat changed to brown.

How far the fact that British forms have a larger number of close allies on the Pacific Coast than in Eastern Canada is due to migration via Asia and how far to the action of similarity of climate cannot be estimated until our knowledge of Siberian forms, at present meagre, is greatly increased. The hairs clothing the body are of value to the bees for gathering pollen for which they are admirably adapted, being branched but unbranched in wasps. Their value for keeping the insect warm in chilly weather is apparently of secondary importance because wasps are almost as scantily clad in the north as in the south, and the parasitic bees are scantily clad. Bright colours and striking patterns, whether of coat or tegument, for instance in *Bombus* and many parasitic bees and many wasp genera, are usually of the warning kind and therefore are liable to regional convergence. In England, most of the species of *Bombus* have a white or a red tail. In Canada the only white or red-tailed species are in the western mountains and the north.

CATOCALA ULALUME, A CORRECTION.

BY G. H. FRENCH, CARBONDALE, ILLINOIS.

It may be unfortunate that Mr. Herman Strecker did not figure all of the new species that he described, for his descriptions, like those of some of the rest of us, were not always clearly drawn. Another unfortunate thing, for me, is that during a few years in which I was compelled to drop entomological work some of my material was lost, among which was *C. ulalume*. The specimens upon which were based my note in the Canadian Entomologist of January, 1919, page 16, were Dr. Holland's *C. carolina*, and that is really a variety of *C. flebilis*. This species is too small for *C. ulalume*.

Since writing the above-mentioned note I have seen material from several localities outside of Southern Illinois, containing a number of forms of *C. lacrymosa* and *C. dejecta*. One of these, I think from Kentucky, has the bluish sheen of *C. dejecta*, with no noticeable brown except a narrow subterminal shade of very dark brown, not noticeable except under the lens. This specimen had t. p. dentation of *C. lacrymosa*, but lacks the white along the t. a. and t. p. lines near the posterior margin of the wing that is so prominent in *C. lacrymosa*. The whole wing is pretty evenly dusted with black atoms.

June, 1919

ON THE MALE AND IMMATURE STATE OF *GRYLLOBLATTA CAMPODEIFORMIS* WALKER.

BY E. M. WALKER, TORONTO.

The remarkable Orthopteroid insect described by the writer as *Grylloblatta campodeiformis*[1] has been hitherto known only from the type and paratype specimens, both of which are mature females. Through the kindness of Dr. C. Gordon Hewitt, Dominion Entomologist, who visited Banff, Alberta, the type locality, in 1916, I have had the privilege of examining seven additional specimens, including a mature male, two mature females and four nymphs, of which three are males and one is a female.

One of the adult females was taken by Dr. Hewitt, in company with Mr. N. B. Sanson, Curator of the Rocky Mountains Park Museum, and is well preserved in alcohol. The other specimens were dried and were found in the collection of the Rocky Mountains Park Museum, with the exception of one male nymph, also dried, from the National Collection. All were taken in the vicinity of Banff, the labels giving the following data:—

"Sulphur Mt., Lab. No. 50, July 18, 1916." (Adult female).

"Sulphur Mt., Oct., 1908, N. B. Sanson." (Adult female).

"Sulphur Mt., Nov. 21, 1910, N. B. Sanson." (Adult male).

"Sulphur Mt., Nov. 21, 1910, N. B. Sanson." (Male nymph, stage A).

"Sulphur Mt., top of trail, on snow, Jan. 24, 1910, N. B. Sanson." (Male nymph, stage B).

"Banff, Nov. 5, 1906, N. B. Sanson." (Male nymph, stage B.)

"Sulphur Mt., trail, Nov. 9, 1915, N. B. Sanson." (Female nymph).

Since the original description of this insect was published several papers by Professor G. C. Crampton have appeared, in which its structure and affinities have been discussed at some length. He has dealt chiefly with the thoracic and cervical sclerites,[2] the antennæ[3] and to some extent with the female genitalia.[4] The latter have been fully investigated by the present writer, and will be described in a paper on the terminal abdominal structures of Orthopteroid insects, which it is expected will appear in the near future.

The present paper will be chiefly confined to a description of the adult male and the immature stages of both sexes, as represented by the material at hand, a full discussion of the phylogenetic relations of *Grylloblatta* being reserved for the future paper just mentioned.

It will be convenient to describe the adult male first, then the immature stages of the male and female, respectively.

The Adult Male.

The adult male measures 16.5 mm. in length, and is similar to the female in every respect, except the terminal abdominal segments and genitalia.

The 8th segment shows no special features, being similar to the 7th and other typical abdominal segments. The 9th segment, on the other hand, is very remarkable. It is of considerable size, larger than that of the female, and about equal in width to the 8th segment. The tergite (Pl. VIII, Fig. 1) is about twice as broad as long, with a slightly and somewhat irregularly arcuate hind

1. Walker, E. M., Can. Ent., 1914, vol. XLVI, pp. 93–99.
2. Crampton, G. C., Ent. News, 1915, vol. 26, pp. 337–350.
3. Crampton, G. C., Can. Ent., 1917, vol. 49, pp. 213–217.
4. Crampton, G. C., Journ. N. Y. Ent. Soc., 1917, vol. 25, pp. 25–237.

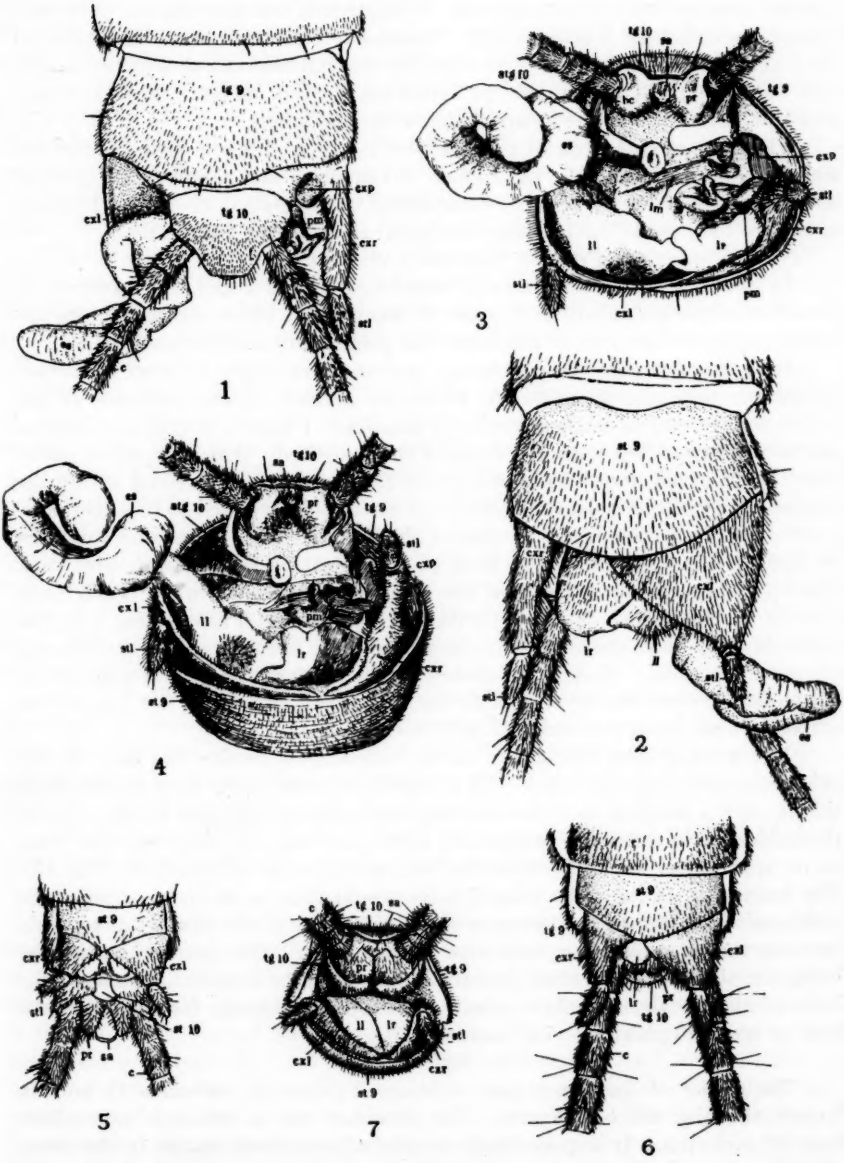
margin, and is nearly if not quite, symmetrical. It is separated from the sternal region only by a suture, there being no distinct pleural membrane (Figs. 8 and 9). The sternal region (Fig. 2) is unique among Orthopteroid insects in being divided into three sclerites, a basal plate, the true "sternite," and two disto-lateral "coxites," which are connected with the sternite by distinct articulations. The sternite is of nearly the same size and form as the tergite, although with a somewhat more decidedly arcuate hind margin and is slightly asymmetrical, being longer on the right side than on the left. The coxites are remarkably asymmetrical and different in form. Both are roughly triangular and bear well-developed styli at their apices. The left coxite (cxl) is a large scoop-shaped plate, whose base extends from the left pleural suture to a point well to the right of the median line. The right coxite (cxr) is of about the same length, but much less than half as broad at base, and is confined to the right side. Its upper margin bears a prominent chitinous process (cxp) directed ento-caudad. Both coxites and styli are thinly pubescent, like the general body-surface, and the styli also bear a few short bristles, chiefly toward the apices.

The 10th segment, as in the female, is much smaller than the 9th, but is fairly prominent. The tergite as viewed from above is symmetrical and trapezoidal in form, being narrowed distally to a truncated apex. Viewed from behind, however, its lateral lobes are seen to be produced mediad beneath the cerci and paraprocts (*laminæ subanales*) into a pair of free, unequally developed arms. The left arm is the longer and is entirely chitinized, except at the tip, which is slightly expanded into a little rounded pad. The right arm is shorter than the left, chitinized only at the base and lacks the pad; having the appearance of an aborted structure. At the base of the cerci, which are similar to those of the female, there is a small ventral basipodite. The supra-anal plate (sa) or "epiproct" is vestigial and feebly chitinized. The paraprocts, which are situated on each side of the anus, are also poorly developed and unchitinized, though pubescent. There is no 10th sternite.

The Genitalia.

The phallus is bulky and irregular, resembling in general appearance that of certain Blattidæ, and also recalling that of the Phasmidæ. It consists of two large lobes separated by an oblique fissure, extending from about the mid-ventral line to the left side at the base of the 10th tergite (Figs. 3 and 4). As seen in Fig. 2 both lobes project well behind the posterior margin of the 9th sternite, the right lobe terminating in the space between the two coxites, while the left lies chiefly in the concavity of the left coxite. The right lobe bears upon its dorso-caudal surface a heavily chitinized prominence (pm), divided into two irregularly folded parts, bearing several blunt, tooth-like processes. Just above it are two nearly horizontal plates (1m), whose freely projecting outer (right) extremities are bent backwards towards the chitinous prominence just described. These parts, together with the right coxa, with which they are associated, appear to form the clasping apparatus, in which the left arm of the 10th tergite may perhaps be included. The exposed part of the right lobe is chitinized and pubescent.

The left lobe is entirely membranous except a small, ventral patch, which is chitinized and pubescent. It is remarkable in being produced into a long, coiled membranous tube, which apparently has no opening but is an evaginated



GRYLLOBLATTA CAMPODEIFORMIS WALK.; STRUCTURAL DETAILS. (P. 138.)

sac, comparable to the sheath of the eversible hook, which is present in the same situation in many Blattidæ, sometimes on the right side, sometimes on the left. There is, however, no hook in *Grylloblatta* on the left side, although the toothed prominence on the right side is apparently its homologue. The purpose of the coiled sac is not evident. It seems to be too far from the opening of the ejaculatory duct to serve as an eversible seminal reservoir or a bursa copulatrix, for although I was unable to detect the genital aperture it is extremely probable that it lies in the fissure between the two lobes.

The disto-medial angle of the left lobe is produced into a rounded process, which fits into a fold of the right lobe. Its inner surface is somewhat grooved and lies in the fissure, possibly functioning as a seminal channel. It much resembles the "penis" of Periplaneta, Blaberus and other Blattidæ.

Probable Copulatory Position.

In the absence of any actual knowledge of the copulatory position in *Grylloblatta* it is perhaps of little value to speculate as to its nature, but the following suggestion may be of some use as a guide to future observations.

It is probable that the copulatory position is radically different from that of the Blattidæ and Mantidæ, in which, on account of the shortness of the ovipositor, an end-to-end connection is possible. I have a female specimen of *Stagmomantis carolina* with a portion of the male body attached, and it shows that the decurved dorso-caudal margin of the ovipositor is received within the genital cavity of the male, the body of the latter being twisted so that its dorso-ventral axis is perpendicular to that of the female. Such a position would be impossible in an insect with so long an ovipositor as Grylloblatta, and it is, therefore, extremely probable that the copulatory position is more nearly comparable to that which is usual in the Orthoptera and Phasmoidea, i. e., the genitalia of the male are applied to the vulva of the female, the two sexes facing the same direction. This is the more probable in that the genital aperture of the female *Grylloblatta* opens directly on the ventral surface at the base of the ovipositor, not being covered by a subgenital plate.

The scoop-shaped left coxite seems adapted to receive the base of the ovipositor, covering the vulva. This would place the right coxa on the right side in such a position as to receive the lower edge of the right dorsal valve of the ovipositor in the notch between its distal part and the chitinous spur (cxp) on its upper edge, which, from its direction would be on its inner side (Fig. 15). The inner edge of the right ventral valve would then be received between the right coxite and the toothed process of the right lobe of the phallus, or possibly between the latter and the transverse laminæ (1m). This position would also bring the oblique fissure more directly in line with the longitudinal axis of the body of the female, and thus permit a more direct passage for the spermatic fluid or spermatophore into the vagina.

The Male Nymph.

The earlier of the two stages represented (stage A) measures 11 mm. in length, the hind tibiæ 2.75 mm. The antennæ, one of which is incomplete, have 22 segments. It is quite similar to the adult in form, except in the somewhat less tapering antennæ, and slightly stouter femora, particularly the profemora, which are nearly half as broad as long, and the terminal abdominal segments and genitalia.

The 9th segment (Fig. 5) is relatively much smaller than in the adult. Its sternal region is clearly divided into sternite and stylus-bearing coxites. The asymmetry is noticeable but far less marked than in the adult, the base of the left coxite being only about 1.5 times as broad as that of the right. Both are ventral in position and triangular in form, with relatively large styli. There is as yet no indication of the spur borne by the right coxite in the adult.

The 10th segment is relatively larger than in the adult and consists chiefly of the tergite, which forms a ring broken only by a small sternal area (st 10). The latter is quite distinct but membranous. There is as yet no distinct appearance of asymmetry in the 10th segment.

In the intersternal membrane between segs. 9 and 10 two slight ventro- lateral raised areas are visible, the rudiments of the two lobes of the phallus (Fig. 10).

The cerci are quite similar to those of the adult except that they are relatively stouter, and the constriction between the first two joints is less clearly defined.

The supra-anal plate and the paraprocts are much more prominent than in the adult, the former being slightly chitinized above, the latter membranous but pubescent.

The two specimens belonging to the older nymphal stage (stage B) measure 11 mm. and 12.5 mm., respectively, the abdomen of the former being contracted. The hind tibiæ in each are about 3.1 mm. long, and measurements of other parts are also closely comparable. The form of the 9th sternum has changed very little from stage A, though the asymmetry of the coxites is a trifle more marked. The principal change is the greater contrast in size between segments 9 and 10. The former is relatively considerably larger, the latter smaller and almost entirely concealed in a direct ventral view (Fig. 6). The ventral edges of the 10th tergite nearly meet one another, there being no longer a distinct 10th sternum. The supra-anal plate and paraprocts are also greatly reduced, almost as much so as in the adult.

Owing to the increased depth of segment 9, the intersegmental membrane on which the phallus develops is now nearly vertical instead of horizontal in position. The two lobes of the phallus (Fig. 7) are much larger, asymmetrical and separated by a fissure having a obliquity similar to that of the adult but less marked. No chitinized areas are as yet present.

The difference in size between these two nymphal stages is so slight that it is almost certain that they represent successive instars.

The Female Nymph.

The single immature female is somewhat larger than any of the male nymphs, measuring 15 mm. in length, the hind tibiæ 3.25 mm. The antennæ have 24 to 25 segments. The 8th abdominal sternum is similar to that of the adult, except that it lacks the pale median area present in the latter, and is less firmly chitinized. The ventral valves of the ovipositor or valvulæ (anterior gonapophyses) arise from the hind margin of the 8th sternum and extend back a little beyond the hind margin of seg. 10. They are straight, subcylindrical, broadest at base, and taper to bluntly pointed apices. The basal segments (basivalvulæ) are well marked off by a distinct constriction. The sternal region of seg. 9 is clearly defined and still has its primitive horizontal position, in line with that of seg. 10; whereas in the adult it becomes vertical, so that the bases of the dorsal and inner valvulæ are directly above those of the ventral valvulæ (not including the basivalvulæ).

The dorsal and inner valvulæ (outer and posterior gonapophyses) arise in the same transverse plane across the middle of the sternum. The former are subcylindrical and terminate in well-developed styli like those of the male, which reach just beyond the tips of the paraprocts, and are about half as long as the valvula itself. The apices of the ventral valvulæ reach to about the ends of the dorsal valvulæ, without the styli, and as the dorsal valves in the adult are distinctly longer than the ventral valves, it is evident that the styli are not cast off at ecdysis, but go to form the apices of the dorsal valves.

The inner valvulæ occupy the space between the outer or dorsal pair, and are contiguous with the latter and with each other at base. They are simple, styliform processes, falling a little short of the dorsal valvulæ without the styli.

A comparison between the structure of the immature and mature ovipositor of *Grylloblatta*, and the remaining parts of the 9th sternum will be made in my later paper. It may be mentioned here, however, that the lateral parts of the 9th segment, shown in Fig. 10 (vf) become the small triangular plates which Crampton has termed the "valvifers."

Concluding Remarks.

It is not my intention to discuss here in detail the phylogenetic relations of *Grylloblatta*, but attention may be drawn to a few points which have a bearing on the problem.

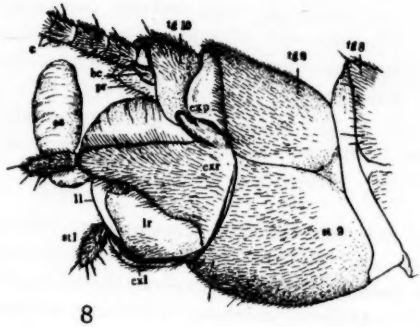
One of the most significant features possessed by the male is the remarkably primitive structure of the 9th abdominal sternum. In no other Pterygote insect, so far as I am aware, is there to be found an abdominal sternum consisting of sternite and separate, undivided coxites, each bearing a simple stylus. In some Ephemerids, such as *Blasturus nebulosus*, the 9th sternum of the male consists of sternite and separate coxites with styli, but either the styli or the apical part of the coxites are secondarily segmented, and even this condition is unusual, as the coxites in the Ephemerida are generally united to form a single plate.

It is in the Thysanura that we find abdominal sterna most nearly comparable to the 9th sternum of the male *Grylloblatta* in respect of the features mentioned. In certain genera of Lepismoidea (*Nicoletia* and *Atelura*) the 9th sternum of the female possesses, in addition to the stylus-bearing coxites (present in both sexes), a sternite overlapping the bases of the coxites.[5] In most of the genera of this order and of the Machiloidea, however, the sternite is absent from the 9th segment, but in the latter group the other abdominal sterna, or most of them, show all these parts, although the coxites are separate from the sternite, and basally from one another, only by sutures.

In this connection it may be added that *Grylloblatta* is interesting as giving additional support, if such be necessary, to the view that the lateral gonapophyses of the female are prolongations of the coxites of segment 9.

Thus in the structure of the 9th sternum of the male, *Grylloblatta* is not only more primitive than any other Orthopteroid insect, but also more so than the Plecoptera, Embiidina and Dermaptera (together constituting the "Panplecoptera" of Crampton) in all of which the division into sternite and coxites, and the styli, have been lost. It is also more primitive than any of the true Orthoptera in the absence of a subgenital plate in the female other than the

5. Escherich, K., Das System der Lepismatiden, Zoologica, 1905, Bd. 18, Heft 43, p. 25.



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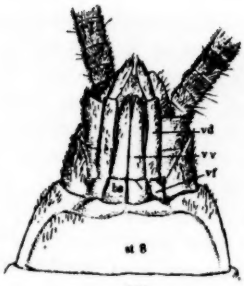

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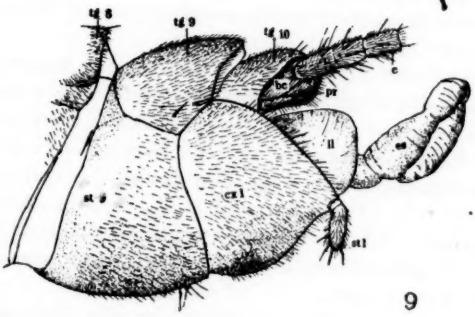

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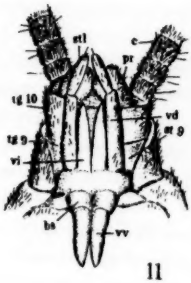

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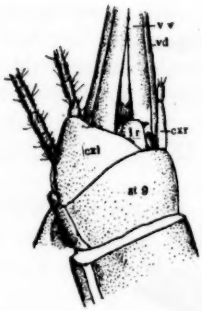

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GRYLLOBLATTA CAMPODEIFORMIS WALK.; STRUCTURAL DETAILS. (P. 138.)

unmodified 8th sternum, and in the details of the ovipositor, which are yet to be described. The immature ovipositor is of a distinctly more primitive type than that of the most generalized Orthoptera of corresponding stage, e. g., *Ceuthophilus* of the Tettigoniidæ. This is seen in the form and position of the valvulæ, the presence of well-marked styli and the more definite basivalvulæ. In these respects it approaches the Blattidæ and Mantidæ, but the valvulæ of the 9th segment have not the terminal position, nor have the dorsal valvulæ the broad, flattened form found in these groups, in which respects they are apparently the more primitive, at least at this stage. The great reduction or complete loss of the ovipositor in the Panplecoptera is, of course, a secondary feature, in which they are negatively specialized, as compared with the majority of Orthopteroid groups.

The male genitalia considerably resemble those of certain Blattoidea and Mantoidea, and also the Phasmoidea, and the fundamental plan of structure seems to be the same in all of these groups, although I believe the asymmetry has been independently acquired in some of them, at least. The true Orthoptera seem at first sight to be constructed upon an entirely different plan, but further investigation tends to indicate that it is a very highly modified form of the same plan.

It is my present opinion that the "Panisoptera" (Blattoidea, Mantoidea and Isoptera), which is unquestionably a natural assemblage, and the Orthoptera together with the Phasmoidea, represent two main branches of the same stem, originating as a section of the Palaeodictyoptera, and that Grylloblatta is the sole survivor of a twig which separated from this stem before the two main branches had become differentiated. The Phasmoidea also separated very early from the Orthopteran branch. The characters in which Grylloblatta and the Phasmoidea resemble the "Panplecoptera" are all primitive ones, and only indicate the common origin of the two stems.

The five-jointed tarsi, which are present in Grylloblatta, the Blattoidea, Mantoidea and Phasmoidea, are characteristic of primitive Orthopteroid insects, but I agree with Crampton's suggestion that the trimerous type may be, after all, the more primitive for the Class Insecta in general. We never find pentamerous tarsi in the Apterygota, nor in any of the Panplecoptera, so that they were probably acquired very early in the Orthopteroid stock, and probably also in other branches of the Palæodictyoptera. The reduced number of tarsal joints in the Isoptera and true Orthoptera is doubtless a secondary feature.

Explanation of Plates VIII and IX.

Abbreviations.

atg 10—arm of 10th tergite.
bc—basipodite of cercus.
bs—basivalvula.
c—cercus.
cxr, cxl—right and left coxites.
cxp—process of right coxite.
es—eversible sac.
lm—laminæ forming part of clasping apparatus.
lr, ll—right and left lobes of phallus.
pm—chitinous process of right lobe of phallus.
pr—paraproct.
sa—supra-anal plate.
st 9—9th sternite.
tg 9, tg 10—9th and 10th tergites.
vd—dorsal valvula.
vf—valvifer.
vi—inner valvula.
vv—ventral valvula.

Plate VIII.—*Grylloblatta campodeiformis*, terminal abdominal segments and genitalia of male. 1, adult, dorsal view; 2, same, ventral view; 3, same, caudal view; 4, same, ventro-caudal view; 5, nymph, stage A, ventral view; 6, nymph, stage B, ventral view; 7, same, caudal view.

Plate IX.—*Grylloblatta campodeiformis*. 8, adult male, right lateral view of terminal abdominal segments; 9, left lateral view of same; 10, female nymph, ventral view of terminal segments; 11, same with ventral valves bent forward to show inner valves; 12, diagram of probable method of coupling; 13, adult male dorsal view; 14, male nymph, stage A; 15, male nymph, stage B.

THE MAY-FLY OVIPOSITOR, WITH NOTES ON *LEPTOPHLEBIA* AND *HAGENULUS*.*

BY EMILY REED MORRISON, WASHINGTON, D.C.

The biological and morphological information contained in this paper was obtained from field trips made at Cornell University in the early summer of 1917, and from a laboratory study of the material thus collected and of related forms in the University collection. The work was undertaken at the suggestion of Dr. J. G. Needham who called the writer's attention to this may-fly and to the unusual structure present on the seventh and eighth abdominal segments of the adult female, and suggested that it might prove an interesting subject for a summer's study, an examination of other related species perhaps revealing similar modifications heretofore unnoted. For this original suggestion and for subsequent additions and corrections to the work, the writer is greatly indebted to him.

This species was first described by Dr. Needham (3) as *Choroterpes betteni* from specimens which had been collected by Dr. Cornelius Betten near Hamburg, N. Y., in 1906. Only adults were available for study at that time, and the species was doubtfully referred to the genus *Choroterpes*. Ten years later Dr. Needham found a swarm of little red may-flies near McLean, New York, which upon examination proved to be the same species; and in the nearby stream were the reddish-brown nymphs which he suspected to be its immature form. An examination of the nymphs showed that they belonged to the genus *Leptophlebia*. The observations and breeding work of the writer confirmed Dr. Needham's opinion that both nymphs and adults were the same species, *Leptophlebia betteni*.

Habitat.

The local habitat of this species is rather unique. It lies in the midst of a series of peat and grass bogs which are located near McLean, New York. Both the fauna and flora of this region are extremely localized, owing to the peculiar manner of the formation of peat bogs. The water in the streams which run through the peat bogs is of a deep coffee colour. It is in such a coffee-coloured stream which runs from a pond in the midst of the bogs that the nymphs of *Leptophlebia betteni* live, on logs which have dropped into the stream and have become water soaked and partially rotted. The brown nymphs were found in the longitudinal fissures of these logs, and so closely do they resemble the wet wood in colour that it is impossible to distinguish them when they remain motionless. On the logs with them may be found numerous Parnid beetles,

*Contribution from the Entomological Laboratory of Cornell University.
June, 1919

Bryozoans and fresh water sponges, together with the comb-horned fish fly, *Chauliodes;* the green may-fly, *Baetis;* Chironomid larvæ; the stone fly *Perla;* such caddis worms as *Hydropsyche;* and the Hydrophilid beetle, *Hydrobius globosus*. This may-fly is also extremely localized in habitat for the imagos were found for a distance of only about twenty feet and were abundant for only about six feet. The immature forms were found in the stream opposite this place of greatest abundance. At this point the stream bed breaks into gentle riffles in which lives the mollusk, *Anodonta footiana*, in some numbers. Just above the riffles the stream bed changes abruptly to soft, black ooze which is filled with another mollusk, *Sphærium*.

The writer visited the stream on the 25th and 30th of June, hoping to find the may-flies swarming, and if possible to observe mating and oviposition. However, the season had been late and cold and there were no swarms, although the nymphs were transforming; both subimagos and adults were clinging to the herbage and shrubs along the stream. Although no egg masses could be found, there were many of the small brown nymphs on the water-soaked wood, and from some of these which were carried into the laboratory it was possible to rear both sub-imagos and adults.

Description of the Stages.

Egg.

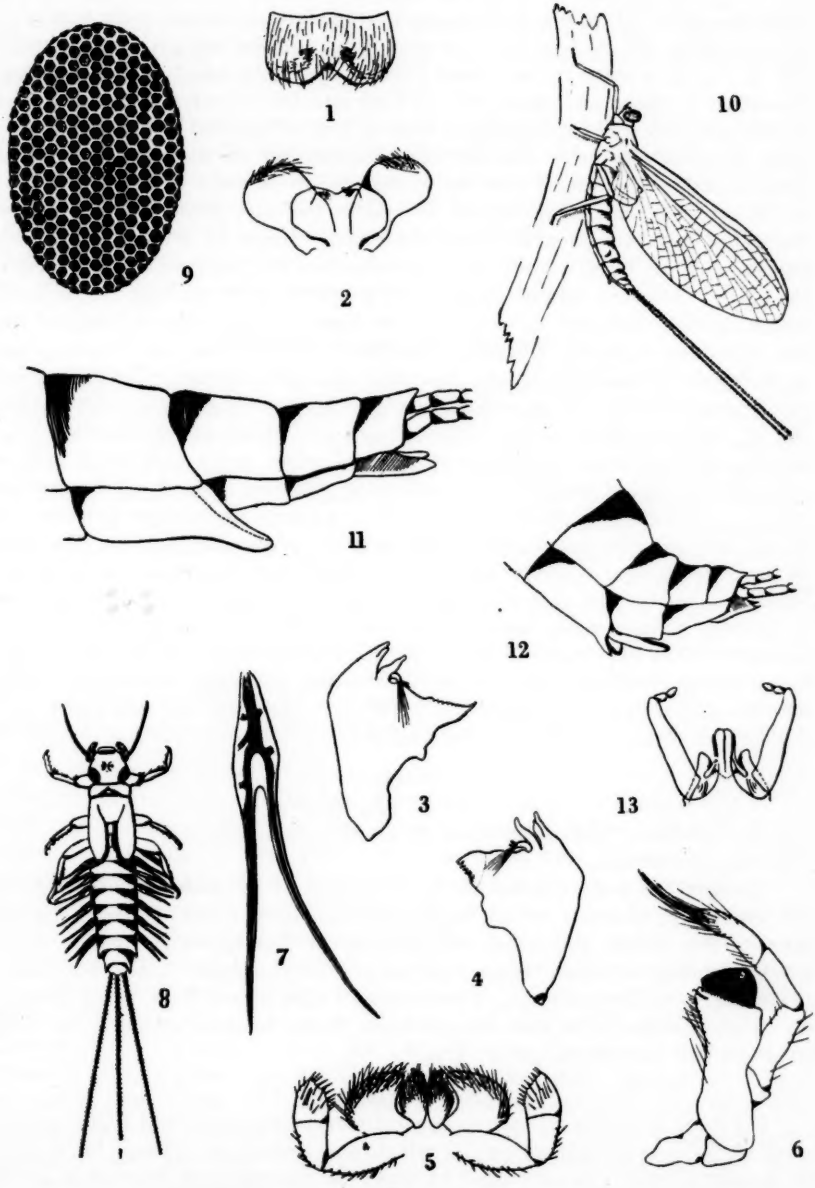
A dissection of the ovaries of a female of this species showed the presence of about six hundred eggs. The following description was made from material thus obtained. The egg (Pl. X, Fig. 9) is broadly ovate, .195 mm. long, by .11 mm. wide. The surface of the egg shell is laid off in numerous minute hexagonal areas with depressed centres. The dissected material was translucent whitish, and it was necessary to stain the shell to bring out the reticulation clearly.

Nymph.

The fully grown nymph (Pl. X, Fig. 8) is 7 mm. long with the three anal setæ 4 mm. long and subequal, and the antennæ 1.7 mm. long. The body is elongate, slender, flat below and slightly convex above. It is widest at the mesothorax, while the prothorax is slightly narrower than the head. The wing pads project posteriorly over the margins of the first two segments of the abdomen. The abdomen is long and narrow, twice as long as the head and thorax combined, widest at the sixth segment and with segments eight and nine produced posteriorly at each lateral margin into a triangular spine, while the caudal margins of segments nine and ten bear a fringe of spines dorsally. The deeply bifurcate abdominal gills are present on the lateral margins of segments one to seven and are all approximately equal in length, with broad basal portion about half as long as each of the slender terminal filaments. The body above is reddish brown in colour and slightly lighter beneath.

Mouth Parts of the Nymph.

The labrum (Pl. X, Fig. 1) is larger than wide and rather deeply incised medially, while on the under surface are a number of fine hairs which aid in straining food particles from the water. The mandibles are very roughly and irregularly triangular in shape, with the articulation and muscle attachment occupying about half of the base and with a group of large, erect fangs



LEPTOPHLEBIA BETTENI (NEEDHAM) AND L. PRÆPEDITA ETN.(?)

projecting at right angles to the axis of each mandible near its apex, while just within this group of fangs is the much smaller movable endopodite, terminating in a tiny brush of differentiated long and short hairs. The molar surface of the right mandible (Pl. X, Fig. 4) is situated on the lateral margin, while that of the left mandible (Pl. X, Fig. 3) is on the outer anterior margin. Each maxilla (Pl. X, Fig. 6) is made up of a basal portion, the cardo, which is roughly broad-triangular in shape and apparently divided into two sclerites. A united galea, lacinia and stipes, oblong in shape, more or less constricted in the middle, with apex diagonally truncate and the base rounded off on the inner side, is apparently attached to both sclerites of the cardo. A short suture at the inner apical corner of this combined sclerite marks the only differentiation between the galea and lacinia, while these structures cannot be separated from the stipes. A thick brush of long, fine hairs borders the truncate distal margin of the galea. The four-segmented palpi are attached about midway on the outer margin of this combined sclerite, with the basal segment minute tringular and the remaining segments elongate cylindrical. The second and fourth palpal segments are subequal in length, the third is a little shorter. The apical segment terminates in a cluster of hairs nearly as long as the segment. The labium (Pl. X, Fig. 5) consists of a ligula divided into oval glossæ and much wider paraglossæ, a pair of large, three-segmented labial palps, and a very much reduced and undifferentiated mentum, submentum and palpifer. The glossæ are clothed, except at the base with short, fine hairs, have a row of short, stout spines on the lateral margin, and terminate at the apex in a hook-like spine. The hairs on the distal portion of the paraglossæ are much longer than those on the glossæ. The apical segment of each labial palpus possesses a row of rather stout hairs on its inner margin, while there are finer hairs on the outer margins of the basal segments. The hypopharynx (Pl. X, Fig. 2) which normally lies closely applied to the labium, is divided into a central piece and two large lateral lobes which have long, fine hairs on their distal portions, while there are two short tufts close to the median margin of the central piece.

Adult.

(Pl. X, Fig. 10).

Dr. Needham (3) has described the adult as follows:—

"*?Choroterpes betteni*

"Length 5–6 mm.; expanse 10–11 mm.; setæ of the male 5–6 mm., and of the female 4½–5 mm.; colour nearly uniform, dark reddish brown, slightly paler on the middle abdominal segments in the female; wings hyaline, veins pale brown; legs yellowish brown, hind femur with two darker bands, fore femur of the female wholly dark; setæ pale yellowish with brown rings, three in number, equal; forceps of the male pale brownish, darker beneath with one very long basal and two very short apical joints."

Male Genitalia.

The male genitalia follow the general plan of structure which is constant in all of the species of *Leptophlebia* which were examined. They (Pl. X, Fig. 13) consist of paired penes placed between the forceps, each limb of which is made up of one long stout, slightly tapering basal segment and two small oval terminal segments, equal in size. The penes form an unjointed lobe-like pro-

tuberance, about half the length of the basal forceps arm, the paired arrangement, which shows distinctly in other species, being indicated only by a deep median cleft. The sperm ducts terminate in a pair of openings at the end of the paired lobes, while from below the middle of each margin there projects upwards and outwards as far as the base of the lobe, an elongate slender structure, slightly clavate near the apex.

So very distinct are these variations in structure that they may be used to separate the species. Thus in *Leptophlebia mollis* (Pl. XI, Fig. 11, 12) the basal portion of the basal forceps segment is decidedly enlarged and there extends from each of the divided penes a distinctly sword-shaped protrusion.. And in a form closely resembling *Leptophlebia præpedita** (Pl. XI, Fig. 13, 14) there is a small, additional segment at the base of each forcep limb, and the penes are long with a proportionately smaller lateral extension.

The Ovipositor in May-flies.

That a modification of the abdominal segments about the egg-valve, (that is ventrally between segments seven and eight) exists in certain may-flies, has previously to the description of *L. betteni*, been noted apparently by but two other workers. Dr. Hagen (2) seems to have been the first to note the presence of any such modification, for he states (p. 2) "Some of the females have a rounded egg-valve at the antepenultimate abdominal plate;" and again in characterizing the genus *Potamanthus* which included the *Leptophlebia* of modern writers, he states (p. 17) that the egg-valve is long. Dr. Eaton (1) in his Monograph of the Ephemeridæ, (p. 2) makes the following statement:—

"In the female the oviducts terminate separately in the joining of the seventh and eighth segments; there is no real ovipositor, but in some genera (e. g., *Heptagenia*) the apex of the seventh segment is produced into a short, rounded flap, and in one *Hagenulus* this projection takes the form of a spout."

In order to determine if this modification existed in any other forms, the writer made an examination of several species of the genus *Leptophlebia*, of the related genus *Choroterpes*, and the genus *Heptagenia*, all of which had been collected near Ithaca, New York. In *Choroterpes* and *Heptagenia* no trace of such a condition could be found, but in two species of *Leptophlebia* other than *betteni* there was a marked differentiation in the ventral structure of segments seven and eight between which the egg-valve opens. *Leptophlebia mollis* shows the simplest condition in this respect. The ventral portion of segment seven extends backward very slightly, as compared with the other abdominal segments, to form a broad truncated lobe, under which lie the two openings of the oviducts. Plate XI, Fig. 10 shows the ventral aspect of the abdomen at this point. In the centre of segment seven are two prominent conjoined ganglia (*n*) on either side of which lies an oviduct (*o*) filled with eggs, opening beneath the lobe. The modification of segment eight consists of two rounded chitinous ridges, converging posteriorly, covered with small

*"This is the *Leptophlebia præpedita* (?) Etn. of Needham's 'May-flies and Midges of New York" (N. Y. State Mus. Bull. 86, pp. 49-51, 1904, Pl. 11, Fig. 1, 2) and the nymph is there described. The gills lack the basal tracheal stubs that are shown in both the forms figured in this paper."—J. G. N.

spinules, with a concave area between the ridges, placed on the anterior third of the segment and extending nearly to the truncate lobe of the seventh segment. In *Leptophlebia submarginata* these last mentioned ridges are closer together and shorter and completely covered by a mid-ventral triangular prolongation of the apex of segment seven.

In *Leptophlebia præpedita* (?) (Pl. X, Fig. 11) the posterior portion of the seventh abdominal sternite is still more elongated, extending outward and backward so as to be distinctly visible from the side. Segment eight is but slightly modified. *Leptophlebia betteni* shows a further specialization in which both segments seven and eight are conspicuously involved (Pl. X, Fig. 12). The greatest development occurs in segment eight, the expanded portion of which is extended ventrally into a long and narrow, distinctly ovipositor-like organ the tip of which is quite heavily chitinized and basally into a short egg guide. A backward prolongation of segment seven forms with segment eight a channel for the passage of the eggs. An internal dissection showed that the oviducts, extend to the egg-valve and open separately at its base. One species of *Hagenulus*, which is found in Cuba has a much longer ovipositor-like extension (Pl. XI, Fig. 8) than has *Leptophlebia betteni*. A female specimen of this form, which is in the Museum of Comparative Zoology at Cambridge, Mass., was kindly loaned by Dr. Nathan Banks, and upon examination it was found that segment seven extends beyond the apex of the abdomen, folding together toward the tip in a tubular form with an opening on the upper surface. Three chitinous ridges extend along the under surface, converging to the tip. The oviducts extend and open separately, the eggs passing into the ovipositor in two strings whose identity is lost as they pass out of the aperture in a cylinder.

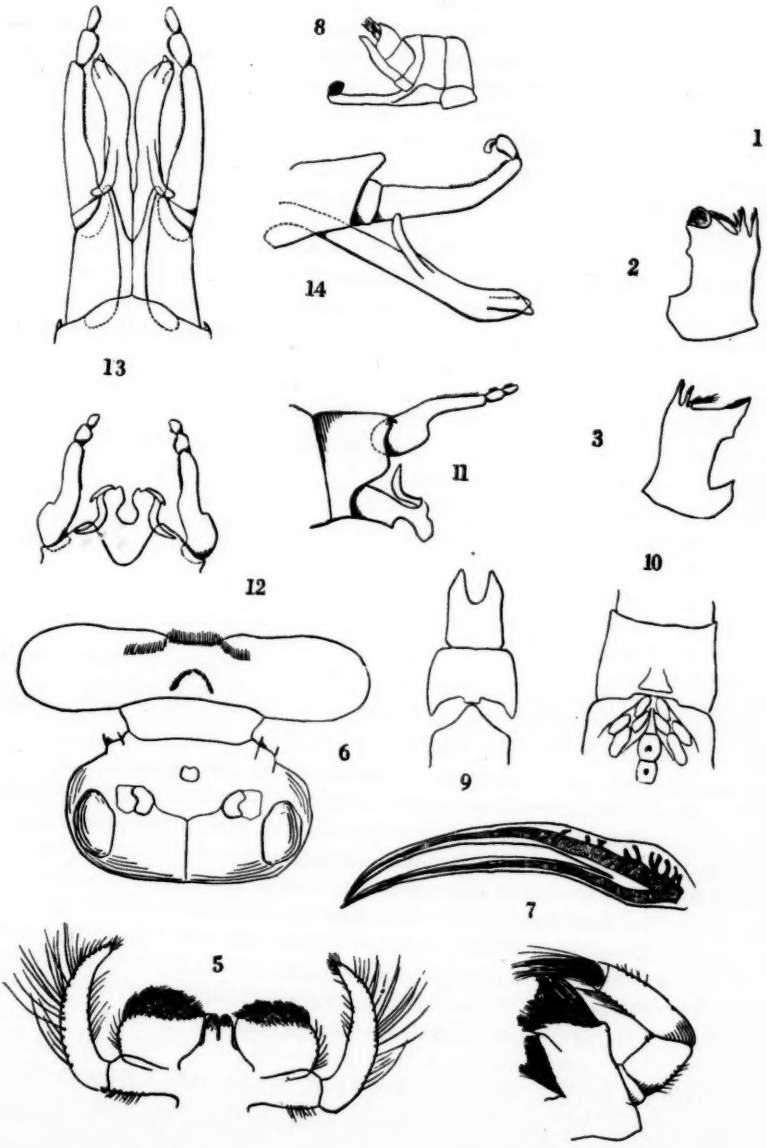
No nymphs of the genus Hagenulus have hitherto been made known; but a specimen collected by Professor C. F. Baker in Cuba and sent to Dr. Needham, in whose slide collection it now appears, dissected and mounted, has enabled the writer to present herewith Figures 1 to 7 of Plate XI. Noteworthy are the inequilateral gills, the form of both labial and maxillary palpi, and most remarkable of all, the extraordinary lateral extension of the labium, its breadth greatly exceeding that of the head.

Bibliography.

(1) 1883. Eaton, Rev. Alfred Edwin. A Revisional Monograph of Recent Ephemerida or May-flies.—Part I by Rev. A. E. Eaton. In the Transactions of the Linnean Society of London, 2nd Ser. Zoology, Vol. III, Part 1 (1883) p. 1–281, pl. 1–63.

(2) 1863. Hagen, Hermann August. Synopsis of the British Ephemerida. In the Entomologist's Annual for MDCCCLXIII, (1863) p. 1–35.

(3) 1908. Needham, James G. New Data Concerning May-flies and Dragon Flies of New York. In Museum Bulletin 124, 33rd Report of the State Entomologist on Injurious and Other Insects of the State of New York, 1907 (1908), p. 188–198, pl. 10.



HAGENULUS AND LEPTOPHLEBIA; STRUCTURAL DETAILS.

EXPLANATION OF PLATES.

Plate X.

Leptophlebia betteni.

Figure 1. Labrum of nymph.
" 2. Hypopharynx of nymph.
" 3. Left mandible of nymph.
" 4. Right mandible of nymph.
" 5. Labium of nymph.
" 6. Maxilla of nymph.
" 7. Abdominal gill of nymph.
" 8. Fully grown nymph.
" 9. Egg.
" 10. Adult female.

Leptophlebia præpedita (?).

" 11. Lateral view of end of abdomen of female.

Leptophlebia betteni.

" 12. Lateral view of end of abdomen of female, showing an egg partly extruded between the prolongations of segments 7 and 8.

Plate XI.

Hagenulus sp.

Figure 1. Hypopharynx of nymph.
" 2. Right mandible of nymph.
" 3. Left mandible of nymph.
" 4. Maxilla of nymph.
" 5. Labium of nymph.
" 6. Head and labium of nymph.
" 7. Inequilateral abdominal gill of nymph.

Hagenulus caligiatus.

" 8. Lateral view of end of abdomen of adult female, showing ovipositor bearing extruded egg-mass at its tip.

Leptophlebia submarginata (European).

" 9. Ventral view of segments 7, 8 and 9 of female, 7 and 8 being slightly separated to show prolongations that form the egg-guide.

Leptophlebia mollis.

" 10. Ventral view of segments 7 and 8 of adult female.
" 11. Lateral view of male abdominal appendages.
" 12. Dorsal view of male abdominal appendages.

Leptophlebia præpedita (?).

" 13. Dorsal view of male abdominal appendages.
" 14. Lateral view of male abdominal appendages.

DELPHACIDÆ OF THE BRITISH MUSEUM—ERRATUM.

On p. 7, line 16, for "3, Pundaluoya simplex Dist." read "3, Pundaluoya simplicia Dist."

F. MUIR.

THE PROPLEURA AND THE PRONOTAL SULCI OF THE ORTHOPTERA.

BY E. MELVILLE DUPORTE, MACDONALD COLLEGE (MCGILL UNIVERSITY).

A few months ago while studying the musculature of *Gryllus pennsylvanicus*, I was impressed by the evident homology of the muscles of the meso- and metapleura with those attached to what I then thought was simply an entopleural apodeme of the prothorax. It occurred to me that this process might really represent the propleuron which externally is limited to a small triangular sclerite in front of the coxa. Examination of other Orthoptera convinced me of the correctness of this view. Recently Crampton* has shown that in *Dissosteira carolina* the pleural region is not "crowded out" but overgrown by the pronotum. This is the first published observation on this peculiar condition in the Orthoptera, and it has induced me to collect and publish my own notes on the subject.

I was pleased that Dr. Crampton in his paper drew attention to the misapplication of the terms *prescutum*, *scutum*, *scutellum* and *postscutellum*, in reference to the areas of the pronotum cut off by the sulci. Since it is generally accepted that the sclerites of the meso- and metathorax to which these terms are applied developed as a consequence of the growth of wings on these segments, and since there is no evidence that the prothorax has ever borne wings it is evident that the pronotal areas cannot be homologous with those of the hinder segments.

I hope to show that the overgrown pleuron is general throughout the Orthoptera (*sens. str.*), and that the sulci of the pronotum are integumental folds which originated as the result of mechanical stress.

a. THE PROPLEURON.

The Acridiidæ (Pl. XII, Figs. 1–3, 12).

Rhomalea microptera. (Figs. 1 and 2). Externally the episternum is visible as a small, triangular sclerite (Fig. 1, est.) protruding from beneath the anterior half of the ventral edge of the pronotum. The position of the overgrown region of episternum is indicated externally by a darker pigmented and more densely punctate area on the pronotum in front of the third sulcus, and its anterior edge is outlined by a lightly impressed dotted line (Fig. 1). The pronotum can be lifted and cut away from the episternum without difficulty as the two are not very closely united. From within the episternum appears as a triangular sclerite with a convex anterior edge. It extends dorsad nearly half way up the pronotum. Its posterior edge lies against the third sulcus and is inflexed, uniting with the similarly inflexed anterior edge of the epimeron to form the entopleurite (Fig. 2, entp.), a triangular ridge which at its apex near the ventral edge fuses with entosternite or furca. A similar entopleural ridge is formed in the meso- and metathorax of this and other orthopterous insects (cf. Fig. 13, entp. 2).

The *epimeron* (Figs. 1 and 2, epm.) is a very narrow sclerite hardly visible externally except at its junction with the episternum. Its position, like that of the episternum, is indicated externally by a more densely punctate area at

*Crampton, G. C., The Thoracic Sclerites of the Grasshopper, *Dissosteira carolina*, Ann. Ent. Soc. Am., vol. XI, p. 347, Dec., 1918.

the ventral edge of the pronotum. It tapers posteriorly to a point which is attached near the posterior ventral angle of the pronotum.

Much the same conditions are found in the other Acridiidæ examined, viz., *Melanoplus*, *Dissosteira*, (Fig. 3) *Stenobothrus*, *Chortophaga*, *Camnula* and *Acridium*.

The Tettigidæ. (Figs. 4 and 5).

Tettix granulatus. A notch in the edge of the pronotum exposes a very small portion of the ventral edge of the episternum (Fig. 4, est). Internally the appearance is similar to that of the Acridiidæ. The episternum narrows more abruptly and the epimeron is shorter and more narrowed posteriorly. The entopleurite is thin and quite deep. The entosternal arch (Fig. 5, ents.) fuses with the entopleurite near its dorsal end and not, as in the Acridiidæ, near the ventral end.

The Locustidæ. (Figs. 6, 7 and 8).

Conocephalus (Fig. 6). Externally a very small, triangular portion of the episternum may be seen lying cephalo-laterad of the coxa. The greater portion of this sclerite, however, lies on the inner side of the pronotum extending more than half way towards the dorsal median line. The anterior edge is inflexed slightly and almost parallel with the posterior edge; the dorsal edge is rounded. The entopleural ridge projects ventrally and articulates with the coxa. At the dorsal end of the pleuron the epimeron is represented by a very small, narrow sclerite. At the ventral end there is a short, narrow, rod-like sclerite projecting backwards in much the same position as the epimeron in the Acridiidæ but very much more reduced.

The pleural regions of *Xiphidium* are very similar to those of *Conocephalus*.

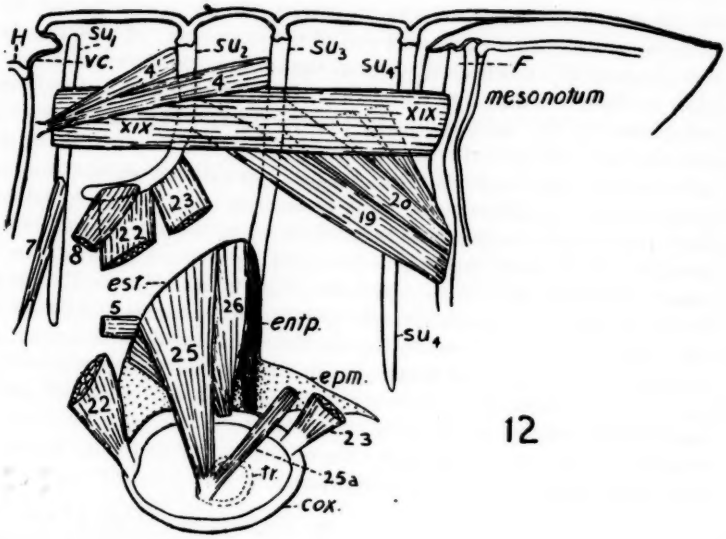
Microcentrum (Fig. 7). Here the episternum is triangular, tapering dorsally. The epimeron is very narrow and, as a free sclerite, is confined to the dorsal half of the pleuron. It projects dorsally some distance beyond the episternum.

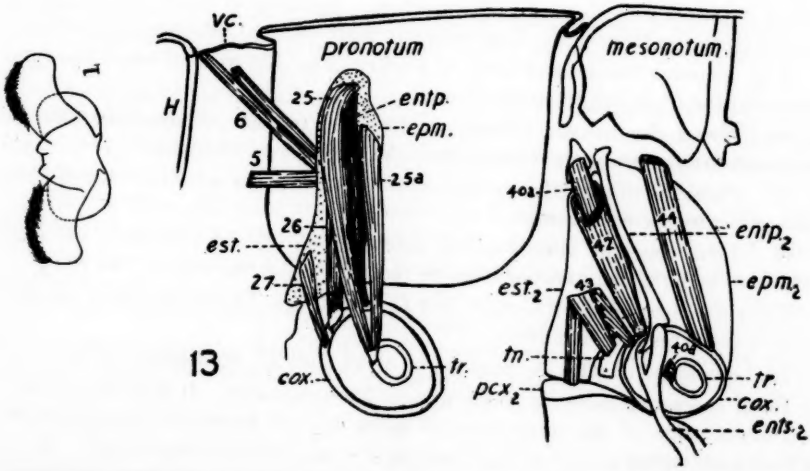
Ceuthophilus maculatus (Fig. 8). The episternum is broad and deeply bilobed. The entopleural ridge is strong and curved; the epimeron is very narrow, widest at the dorsal end and extending almost to the ventral edge of the pronotum.

The Gryllidæ. (Figs. 9, 10, 11).

Gryllus pennsylvanicus (Figs. 9 and 10). The pleuron extends dorsad almost to the median line. It is irregular in shape, and as it follows the curve of the pronotum is itself pronouncedly curved. The episternum is narrow but well developed, and the ventral edge projects slightly below the pronotal edge. The entopleural ridge is deep and projects ventrally, articulating with the coxa by a ball and socket joint. The epimeron is narrow and is best developed dorsally. It does not descend as far as the ventral edge of the pronotum.

Œcanthus nigricornis (Fig. 11). In Œcanthus the pleuron is completely overgrown by the pronotum. The anterior ventral angle projects slightly beyond the membranous integument (shown by the dotted line) connecting the pronotum and the sternal sclerites, so this small portion of the episternum can be seen on the ventral side beneath the flange-like edge of the pronotum. The episternum is broadly oblong. The entopleural ridge is narrow and but





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slightly raised; as in the Locustids and in the other Gryllids it projects ventrally and articulates with the coxa. The epimeron is very narrow, almost as deep as the episternum and practically uniform in width except at the ventral end, where it projects farther caudad. It is entirely an internal sclerite.

In the insects described it is possible to trace a distinct gradation in the development of the propleura as ental sclerites. In the Acridiidæ (Figs. 1–3) the ventral end of the pleuron had undergone but little change and still stretches from the anterior to the posterior end of the prothorax. The epimeron is greatly reduced dorsally, much more so than the episternum. It is possible to lift the edge of the pronotum and show that the episternum is a continuous sclerite overgrown by the pronotum. In the Tettigidæ (Figs. 4, 5) the epimeron is still further reduced. In the Locustidæ (Figs. 6–8) the ventral end of the epimeron no longer extends to the posterior end of the segment but is gradually disappearing, the last vestige of it remaining in the Conocephalinæ (Fig. 6). After this we find the epimeron reduced to a very narrow sclerite, best developed dorsally. In *Ceuthophilus* (Fig. 8), except for the broad anterior lobe the pleuron closely resembles that of the Gryllidæ (Figs. 9 and 10). In the Locustidæ and Gryllidæ, unlike the Acridiidæ, the episternum is fused with the ventral edge of the pronotum and (at least in the Gryllidæ) have only a muscular attachment with the inner face of the pronotum, so that the internal portion of the pleuron has the appearance of a process of the small externally visible portion of the episternum; only by comparison with the Acridiidæ, and by a study of their musculature in comparison with that of the hinder segments of the thorax can their true nature be definitely ascertained.

The Musculature of the Propleuron. (Figs. 12 and 13).

The reason why the propleuron has persisted in spite of the fact that its position and function as an external lateral wall of the prothorax has been usurped by the overgrowing tergite, probably lies in the fact that important muscles of the leg arise from its inner surface. As fewer of these muscles arise from the epimeron this sclerite is accordingly more reduced than the episternum.

If we examine the mesopleuron of *Gryllus* (Fig. 13) we find the following muscles arising from the episternum.

40a. *From* the basalar sclerite, a detached portion of the episternum, *into* the anterior edge of the trochanter. An extensor of the femur.

42. *From* the dorsal edge of the episternum *into* the anterior edge of the coxa. An extensor of the coxa.

43. *From* near the middle of the sclerite *into*, (1) the precoxale, (2) the trochantin, and (3) the anterior edge of the coxa. An extensor of the coxa.

The pro-episterum of *Rhomalea* and *Gryllus* (Figs. 12 and 13) show homologues of these muscles as follows:—

25, homologue of 40a; 26, homologue of 42, and 27, homologue of 43.

From the proepimeron a single muscle 25a originates. It is inserted into the anterior edge of the trochanter. I have not yet found its homologue in the hinder segments.

A similar homology exists between the muscles of the propleuron and those of the metapleuron.

b. The Sulci.

Rhomalea microptera (Figs. 1, 2 and 12), having four well developed pronotal sulci gives good material for a study of these structures. The first sulcus (su_1) lies a very short distance behind the anterior edge of the pronotum and does not quite extend either to the median carina or to the ventral edge of the pronotum. The three other sulci all cut the median carina; the second (su_2) runs about half way down the pronotum and curves forward; the third extends to the ventral edge, and its lower half is coincident with the entopleural ridge formed by the infolding of the contiguous edges of the episternum and epimeron; the fourth runs from the median carina almost to the postero-ventral angle of the pronotum. An examination of Figure 12 will show that the first sulcus lies near the line where the infolded integumental membrane of the anterior end of the pronotum merges into the cervical membrane, and marks the furthest point to which the head may be retracted within the prothorax. This sulcus may be regarded then as marking the extremity of the primitive prothorax, the portion of the pronotum in front of this being probably a later developed growth forming a flange to receive and protect the retracted head. The anterior sulcus represents the fold which would naturally be formed when this flanking piece is pushed back by the retracted head. That this is the case is shown in *Tettix granulatus* (Fig. 5) where the prosternum has grown forward, completing the flange formed by the pronotum. In this insect the anterior notal sulcus is continuous with a sternal sulcus (s.su) which marks the position of the anterior end of the sternum in other Orthoptera.

A similar explanation accounts for the origin of the fourth sulcus (su_4).

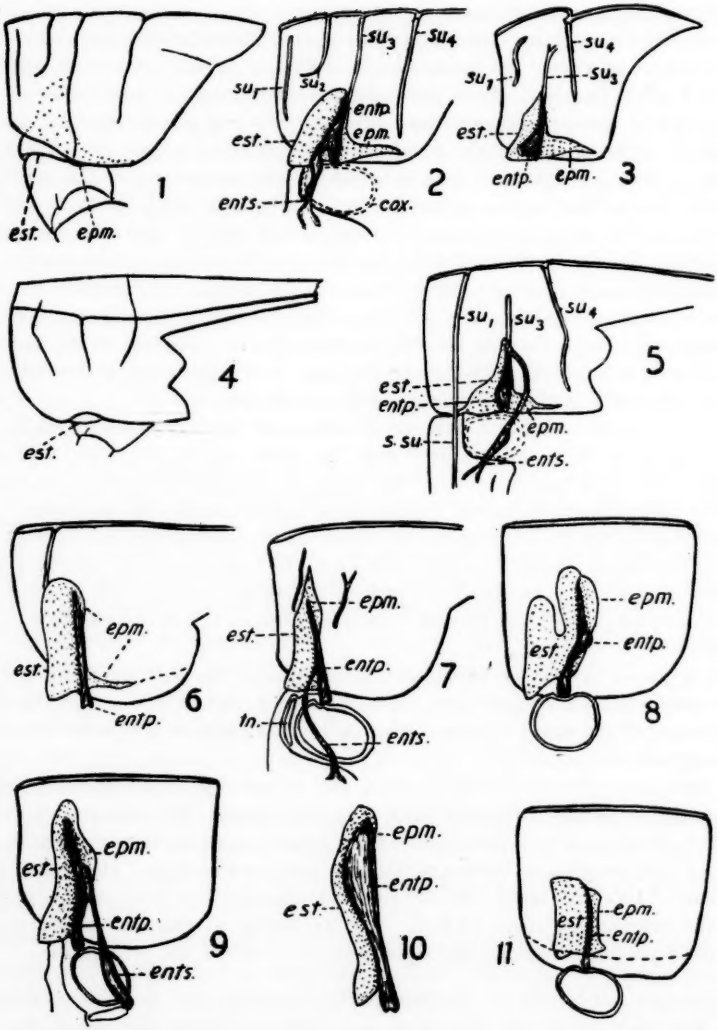
As Crampton (1.c.) has pointed out, the third sulcus originated with the infolding of the contiguous edges of the pleural sclerites to which it is closely attached. This accounts for the origin of the lateral portion of the sulcus, and it will be noted that in *Dissosteira* and many other insects this sulcus does not extend to the dorsal portion of the pronotum. The dorsal portion of this sulcus in *Rhomalea* arose as a result of the pull of the muscles which are attached to it, viz., one head of the third pronotal muscle (20) and one of the elevator of the head (4).

The origin of the second sulcus (su_2) is also due to the pull given the integument by the muscles attached to it. These muscles are an elevator of the head (4), a rotator of the head (8), one head of the third pronotal muscle (19), and an extensor of the coxa (23).

At the time the sulci were formed the integument was probably more flexible and less highly chitinized than it is at present. The method of origin of the second sulcus is well illustrated in the condition which now obtains in the flexible sutural membrane between the pro- and mesonotum. Here the pull of the first (XIX) and third (19, 20) pronotal muscles has produced a distinct fold in the integument (Fig. 12 F.). The hardening of this membrane would undoubtedly produce a sulcus exactly similar to those of the pronotum.

Summary.

1. The propleuron in the Orthoptera has not been forced out by the downgrowing notum, but has persisted on the inner side of the pronotum which has grown over it.



PROPLEURAL AND PRONOTAL SULCI OF ORTHOPTERA.

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2. The episternum, epimeron and entopleural ridge can be easily distinguished though in most cases greatly modified.

3. The pleural sclerites have probably persisted because of their muscular attachments.

4. The musculature of the propleuron is similar to that of the mesopleuron and metapleuron.

5. The sulci are integumental folds formed by mechanical stress due to (a) the pulling of the head and mesothorax against the pronotum, (b) the in folding of the pleural suture, and (c) the pull of the prothoracic muscles attached to them.

REFERENCE LETTERING.

cox.	coxa.
epm.	epimeron.
entp.	entopleurite.
ents.	entosternite.
est.	episternum.
F.	fold in sutural membrane.
H.	base of head.
pcx.	precoxale.
s. su.	sternal sulcus.
su.	sulcus.
tn.	trochantin.
tr.	trochanter.
vc.	veracervix.

Muscles.

4. Elevator of head.
5. Retractor of head.
6, 7, 8. Rotators of head.
19, 20, XIX. Retractors of the pronotum.
22, 26, 27, 42, 43. Extensors of the coxa.
23. Flexor of the coxa.
25, 25a, 40a. Extensors of the femur.
44. Depressor of the wing.

EXPLANATION OF FIGURES.

Fig. 1. External view of the pronotum and propleuron of *Rhomalea microptera*.
" 2. Internal view of same.
" 3. Internal view of pronotum and propleuron of *Dissosteira carolina*.
" 4. External view of pronotum and propleuron of *Tettix granulatus*.
" 5. Internal view of same.
" 6. Internal view of pronotum and propleuron of *Conocephalus*.
" 7. Same of *Microcentrum*.
" 8. Same of *Ceuthophilus maculatus*.
" 9. Same of *Gryllus pennsylvanicus*.
" 10. Anterior view of detached propleuron of *G. pennsylvanicus*.
" 11. Internal view of pronotum and propleuron of *Oecanthus nigricornis*.
" 12. Musculature of the propleuron and pronotal sulci of *Rhomalea microptera*.
" 13. Musculature of pro- and mesopleuron of *Gryllus pennsylvanicus*.

Change of Name.—Prof. R. W. Dawson, of Lincoln, Neb., who is making a special study of the genus *Serica* informs me that my *Serica carinata* (Coleoptera of Indiana, 1910, p. 950) is preoccupied by *Serica carinata* Burmeister (Handbuch IV, 2, p. 175). I, therefore, propose for my Indiana species the name *Serica evidens*, sp. nov.

W. S. BLATCHLEY.

NORTH AMERICAN SARCOPHAGIDÆ: FLIES OF GENUS METOPOSARCOPHAGA TOWNSEND.*

BY R. R. PARKER, BOZEMAN, MONT.

The writer described the species *Sarcophaga pachyprocta* in 1916 (Jour. N. Y. Ent. Soc., vol. 24, pp. 171–175). In connection with the description it was noted that the species was considered to represent a form separable from *Sarcophaga* and possibly should be placed in a distinct genus, but the writer refrained from so doing till it was possible to examine other closely related species. In 1917, however, Townsend made this species the genotype of *Metoposarcophaga* (Proc. Biol. Soc. Wash., vol. 30, pp. 46) but mentioned no other species as belonging to the genus. In the same paper (p. 43) *Sarcophaga incurva* Aldrich was made the genotype of *Thelyleptococnema*. It is the writer's opinion, however, that the two species are congeneric and *Metoposarcophaga* is hereby designated as the name of the genus. *M. tothilli* and *M. pachyproctosa*, new species of the genus, are described in this paper.

The following characters are common to the males of all four species:—parafrontals and genæ silvery grey; front broad, very prominent in profile; vestiture of back of head black or with some light coloured hair close to foramen (in *pachyprocta*); lateral verticals present, greater ocellars as strong or stronger than uppermost pair of frontals; frontal bristles not numerous (six to seven, sometimes eight or nine); epaulet dark; anterior acrostichals well developed; scutellar apicals absent or weak and hair-like; lower sternopleura with bristles only; vestiture of nota of short reclinate bristles that become longer and more slender ventrally; vestiture of fourth ventral plate erect; posterior surface of anterior tibia with two bristles about one-third from distal end (only one in *Sarcophaga* and *Ravinia*); first genital segment much larger than second and its vestiture longer; marginal bristles absent; forceps slender, bent so that prongs are at a pronounced angle to the base; accessory plate at side of forceps (not anterior to them as in Ravinia, etc.), erect and hiding at least part of base of forceps (in *tothilli* and *incurva* only tip of forceps visible from side); claspers on each side united basally (not separate as in Ravinia, etc.); posterior clasper with variously shaped expanded base with bristle at upper anterior angle, distally with a curved hook.

The genus quite naturally divides into two groups, the *pachyprocta* group, containing *pachyprocta* and *pachyproctosa*, and the *incurva* group containing *incurva* and *tothilli*.

The *pachyprocta* group is distinguished by the following characters:—three pairs posterior dorsocentrals; scutellar apicals absent; first vein bristly; costal spine present; posterior tibiæ of normal length; ventrally sides of fourth notum with marginal bristles only; profile of genital segments as in Fig. 1; first genital segment grey pollinose. The penes and claspers very similar but not alike, forceps essentially the same.

Characters of *incurva* group:—four pairs posterior dorsocentrals (sometimes five); scutellar apicals, if present, weak and hair-like; only third vein bristly; costal spine vestigial; posterior tibia much shorter than femur or tarsus; ventrally sides of fourth notum clothed with long, slender bristles; profile of

*Contribution from the Entomological Laboratory of the Montana State College, Bozeman, Mont.

June, 1919

genital segments as in figure 2; first genital segment dull orange, darkened anteriorly; claspers and forceps are essentially alike in both species.

Examination of the figures shows that there is a fundamental likeness in the structure of the accessory genital parts of all four species.

TABLE OF SPECIES.

1. Four or more posterior dorsocentrals, posterior tibia very short.....2.
   Three posterior dorsocentrals, posterior tibia of normal length.....3.
2. Posterior femur normal, tibia short, but not distorted.....*tothilli*, n. sp.
   Posterior femur very large with protuberance beneath bearing a "brush," tibia short and distorted.....*incurva* Aldrich.
3. Anterior clasper reversed S-shaped, penis on long, slender base.....*pachyproctosa*, n. sp.
   Anterior clasper with distal hook and large expanded base, penis on short base.....*pachyprocta* (R. Parker).

Metoposarcophaga tothilli, n. sp.

Holotype (male).—Collection of R. R. Parker.

Male.—Parafrontals and genæ silvery grey; vestiture of back of head black except for some light coloured hairs just below foramen (difficult to see); lateral verticals present, greater ocellars well developed, section III of costa about equal to section X; leg vestiture short; anterior face of posterior femur with only upper row of bristles complete; posterior tibiæ very short, much shorter than either femur or tarsus; anterior acrostichals present; four pairs posterior dorsocentrals (sometimes five); genital segments dull orange except that first is darkened anteriorly.

Length 6–10 mm.

Head viewed from side parafrontals and genæ with dark reflections; transverse impression same colour as genæ. Breadth of front at narrowest part about three-fifths eye width; cheek height approximately three-sevenths that of eye. Front very prominent; width of frontal vitta variable but at narrowest part of front at least twice width of each parafrontal. Second antennal segment dark; third about twice length of second; arista short plumose about to middle. Vestiture of back of head black. Gena with scattering hairs above, below with a row close to lower eye orbit.

Chætotaxy.—Lateral verticals present; vibrissæ inserted slightly above line of oral margin; greater ocellars well developed; frontal rows of bristles extending to or slightly below base of vitta, the lower few pairs divergent from edges of vitta.

Thorax.—Vestiture of mesonotum black, cilia-like, slightly reclinate.

Wings.—Anterior cross-vein more basal than end of first longitudinal; third vein bristly; costal spine vestigial; section III of costa practically equal to section V; calypters whitish, fringed with white hair.

Legs.—Dark, vestiture short. Anterior face of posterior femur with complete upper row of bristles, intermediate row absent, lower row with a few rather weak distal bristles; tibia very short, beardless, about three-fourths length of femur, much shorter than tarsus, middle femur without "comb."

Chætotaxy.—Well developed. Anterior acrostichals present; inner presuturals absent; four pairs posterior dorsocentrals (sometimes five); prescutellar

acrostichals present; scutellar apicals absent or scarcely differentiated; three sternopleurals; lower sternopleura with bristles only.

Abdomen.—Rather short. Clothed above with short, reclinate bristles, beneath with longer, more erect hair; on each side ventral portion of fourth notum clothed with long, slender bristles (not confined to edge as in most species of *Sarcophaga*); ventral plates not rounded posteriorly, fourth clothed with erect hair.

Chætotaxy.—Second segment without marginal bristles or, if present, short, decumbent and inconspicuous; third with two, sometimes very weak; fourth with complete marginal row.

Genital Segments.—Both dull orange except that first is darkened anteriorly. First much the larger, marginal bristles absent: second, flattened, vestiture shorter than that of first; anal area small. Forceps slender, abruptly curved

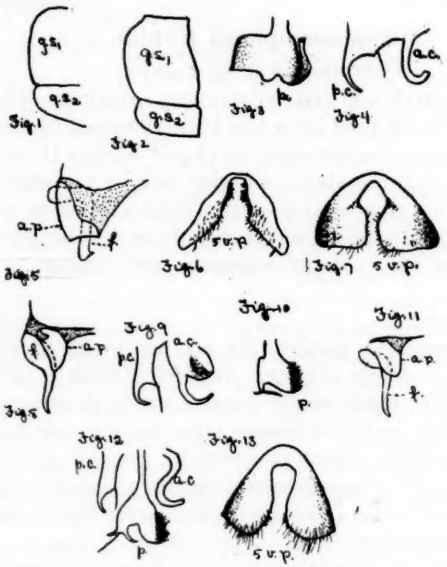

Fig. 22.—*Metoposarcophaga* spp., male genitalia. (Page 157.)

at right angles to the basal portion, distal end slightly enlarged with a short tooth directed forward; forceps in profile view except tip concealed by accessory plate. Penis and accessory parts almost identical with those of *M. incurva* Aldrich.

Described from nine male specimens.

Range.—British Columbia; Savary Island, July 13, 18, 20, 31, 1917, (R. S. Sherman, collector). Holotype taken in same locality and by same collector on July 18, 1917.

The writer has two females which are obviously either *M. incurva* or *M. tothilli* and though the posterior tibia is shorter than the tarsus, it is not as short as in the males of these species nor does it present the peculiar structural modifications found in *M. incurva*.

Metoposarcophaga pachyproctosa, n. sp.

Holotype (male).—Collection of R. R. Parker.

Allotype (female).—Collection of R. R. Parker.

This species is so close to *M. pachyprocta* that a repetition of the description is unnecessary. So far as observed the only reliable differences between the males of the two species are to be found in the characters of the genitalia as here listed.

M. pachyproctosa.

1. Anterior clasper reversed S-shaped (Fig. 12).
2. Penis distinctive, but with long, slender base (Fig. 12).
3. Fifth ventral plate distinctive (Fig. 13).

M. pachyprocta.

1. Anterior clasper with broad expanded basal portion (Fig. 9).
2. Penis distinctive, with short base (Fig. 10).
3. Fifth ventral plate distinctive (Fig. 7).

In addition the second genital segment of *pachyproctosa* is dull orange throughout, and there is a narrow, posterior, dull orange band on the first segment, whereas in *pachyprocta* the second segment is more or less greyish pollinose and the grey pollen of the first segment extends to the middle portion of the posterior margin, at least. These characters may well be variable, however.

I have three females collected in the same locality as the above males. These females are not separable from those of *pachyprocta*, but this species has never been found in several lots of materal from Savary Island. The females are therefore assumed to be those of *pachyproctosa*.

Described from two male and three female specimens.

Range.—British Columbia; Savary Island, July 9, and Aug. 11, 1916. July 11 and 12, 1917, (R. S. Sherman, collector).

M. pachyprocta is known to occur in Mass., N. Y., N. J., Pa., Va., N. C., S. C., Ga., La., Ind., Ohio, Col., S. D., Calif., Manitoba, Cuba (?) and Hayti (?): *M. pachyproctosa* and *M. tothilli* are known only from British Columbia: *M. incurva* occurs in N. Mex., Mont., and British Columbia.

EXPLANATION OF FIGURES.

1. Profile view of genital segments of *M. pachyprocta* R. Parker and *M. pachyproctosa*, n. sp.
2. Profile view of genital segments of *M. incurva* Aldrich and *M. tothilli*, n. sp.
3. Penis of *M. tothilli.*
4. Claspers of *M. tothilli.*
5. Forceps and accessory plate of *M. tothilli.*
6. Fifth ventral plate of *M. tothilli.*
7. Fifth ventral plate of *M. pachyprocta.*
8. Forceps and accessory plate of *M. pachyprocta.*
9. Claspers of *M. pachyprocta.*
10. Penis of *M. pachyprocta.*
11. Forceps and accessory plate of *M. pachyproctosa.*
12. Claspers and penis of *M. pachyproctosa.*
13. Fifth ventral plate of *M. pachyproctosa.*

ABBREVIATIONS.

a. c. anterior clasper.
p. c. posterior clasper.
a. p. accessory plate.
f. forceps.
p. penis.
g. s. 1 and g. s. 2 first and second genital segments.
5 v. p. fifth ventral plate.

A NEW CISIDE GENUS WITH NEW SPECIES FROM MANITOBA.

BY CHARLES DURY, CINCINNATI, OHIO.

Dolichocis, new genus.

This genus is proposed for a species of narrow and elongate form, having a combination of the characters of *Cis* and other described Ciside genera. It has the antennæ 9-jointed, the elytra finely beaded along suture. The prothorax at side edges strongly margined and finely serrate.

Dolichocis manitoba, n. sp.

Elongate, narrow, oval in form. Brownish piceous in colour, when mature. Vestiture of rather sparse, pale setæ. Punctures deep and strong, those of prothorax closer and finer than those of elytra. Head—epistoma subtruncate and margined. Palpi thick, with terminal joint oval and blunt at tip. Prothorax as long as wide, with sides rounded, margined and with finely serrate edges. Elytra two and one-fourth times as long as wide. Beneath the prosternum is flat between coxæ, and long before them. Fore tibiæ not produced at outer tip. Males with a sharp, round fovea on first ventral. Length 2 mm.; width 07 mm.

Aweme, Manitoba. Norman and Talbot Criddle. From fungus growing on ash and elm. Twenty specimens; in the Canadian National Collection at Ottawa, Ont., and in my collection at Cincinnati, Ohio.

Cis criddlei, new species.

Elongate, with sides straight, colour piceous, vaguely paler on posterior third. Vestiture of conspicuous hairs arranged without order. Head with epistoma truncate and narrowly reflected. Prothorax as wide as long, sides feebly rounded. Hind angles viewed from above almost right angled. Punctures dense and deep. Elytra twice as long as wide, more sparsely and coarsely punctured than the prothorax. Beneath, the male has a large fovea on first ventral segment. Length 2 mm.; width 1 mm.

Aweme, Manitoba. Norman Criddle. Eight specimens; in Canadian National Collection at Ottawa, Ont., and my collection, Cincinnati, Ohio. This species is the size and shape of *Cis wenzeli*, but differs from that and all other species known to me in structural characters.

ON SOME TINGIDÆ NEW TO THE FAUNA OF CANADA (HEMIP.).

BY CARL J. DRAKE, SYRACUSE, N.Y.*

Corythucha salicis Osborn and Drake.

Specimens of this insect were taken on willow, *Salix discolor*, at Aweme Manitoba, Aug. 13, 1918, by Mr. N. Criddle; other specimens were collected at Trenton, Ontario, Sept. 11, 1910, by Mr. Evans. From the United States specimens are at hand from Montana, Wisconsin, New York, Massachusetts and New Jersey. The known food plants are willow, *Salix* spp., and currants; *Ribes* sp.

Corythucha elegans Drake.

Mr. H. Groh took a few specimens of this species at Ottawa, Ontario, Oct. 13, 1908, on poplar, *Populus balsamifera;* two specimens were collected in Ontario, July 27, 1903, by Mr. Evans. One specimen is before me that bears the locality label "Mich." The type specimens are from Colorado. During the summer of 1917 and 1918 the writer noted hundreds of specimens, adults, nymphs and eggs, on willow in the vicinity of Cranberry Lake, New York.

Corythucha padi Drake.

Chilliwack, British Columbia, collected by Prof. F. C. Ewing. This insect breeds upon the western choke cherry, *Prunus demissa*. Specimens have been examined from Oregon, Washington, Idaho and Montana.

Corythucha parshleyi Gibson.

Several specimens, collected on walnut (*Juglans nigra*), butternut (*Juglans cincerea*), Japanese walnut (*Juglans sibboldiana*) and juneberry (*Amaelanchier intermedia*). It is a common insect in the eastern part of United States, ranging from Canada to North Carolina.

Corythucha heidemanni Drake.

Two specimens, collected at Ottawa, Canada, by Mr. W. H. Harrington. This is a common insect that infests birch in the vicinity of Cranberry Lake, New York.

Corythucha betulæ Drake.

Two specimens from Ottawa, Canada, collected by Mr. Harrington. Thousands of specimens, adults, eggs and nymphs, have been seen by the writer on yellow birch, *Betula lenta*, in Adirondack Mountains, near Cranberry Lake, New York, during the summers of 1917 and 1918. Two specimens have also been examined from Maine.

Corythucha immaculata Osborn and Drake.

Lilloet, British Columbia, collected by Mr. A. W. A. Phoir. This species infests balsam root, *Balsamorrhiza sagittata*. Specimens are at hand from Oregon, Washington, Idaho, Montana and California.

Corythucha hewitti, new species.

Four specimens, taken on hazelnut, *Corylus americana*, October 8, 1918, at Aweme, Manitoba, by Mr. N. Criddle. Length 2.78 mm.; width 1.5 mm. *Type* and *paratype* in the National Collection of Insects, Entomological Branch, Ottawa; *paratype* in the author's collection. Named in honour of Dr. C. Gordon Hewitt, Dominion Entomologist.

Hood moderately elevated, the length slightly less than twice its height.

*Contribution from the Department of Forest Entomology, the New York State College of Forestry, Syracuse, New York.

Median carina slightly raised anteriorly; outer carinæ normal. Spines moderately long, the tips dark fuscous. Reticulations of the hood moderately large, slightly larger than those of the paranota. Tumid elevations of the elytra normal; costal area triseriate, the outer margin slightly concave.

A small spot on the paranota, another on the median carina, and greater part of the dorsal portion of the hood dark fuscous. Body beneath blackish, sometimes slightly tinged with reddish. Nervures whitish. Elytra with a band across the base, another near the apex, a spot on the paranota, part of the inner portion of sutural area dark fuscous. The apical band of the elytra without large hyaline cells; some cells with tiny hyaline centres. Legs and antennæ yellowish white.

Readily separated from the hazelnut tingid, *Corythucha coryli* Osborn and Drake, by the much less elevated hood. Akin to *C. bellula* Gibson, from which it may be distinguished by slightly longer spines, the globose portion of the hood being much less narrowed dorsally and not distinctly angulate at the crest, darker colour pattern, the apical band of elytra without large hyaline areolæ.

DESCRIPTIONS OF FOUR NEW PARASITIC HYMENOPTERA.

BY S. A. ROHWER, BUREAU OF ENTOMOLOGY, WASHINGTON, D.C.

Tetrastichus rugglesi, new species.

Female.—Length 1.75 mm. Subopaque dark blue, without sculpture; intraocellar line subequal with the ocellocular line; antennæ eight-jointed; one ring joint a three-jointed funicle and two-jointed club; funicle joints subequal in length and subequal in length with the pedicle; club one-fourth shorter than two funicle joints, pointed apically, the apical joint longer than the preceding one; mesonotum with a rather faint median furrow; scutellum with two well-defined furrows; propodeum smooth, shining; prepectus sculptured like mesopleure, i. e., smooth and shining; abdomen ovate, ovipositor sheath slightly exserted; costal margin of hind wing with one spine. Antennæ brown; scape, tibiæ and tarsi and narrow apices of femora yellowish-white (tibiæ somewhat infuscated medianly); wings hyaline, venation yellowish.

Type-locality.—University Farm, St. Paul, Minnesota. Described from eleven females (one type) reared as parasites of *Agrilus arcuatus* by A. G. Ruggles. Material reared July 24, 1916, (type), July 11, 1916, and September 16, 1915.

Type.—Cat. No. 22132. U. S. Nat. Mus.

Trigonura hicoriæ, new species.

Female.—Length 4.5 mm. Head with large umbilicate punctures; area between eyes about one-fourth greater than length of eye; antennal foveæ smooth; antennæ thirteen-jointed with one ring joint; ocellocular line slightly shorter than the interocellar line, and not much greater than the greatest diameter of a lateral ocellus; thorax with large umbilicate punctures, smaller and closer on the prothorax; the depressed area of mesepisternum in which the middle leg fits transversely striate; legs shining with very fine scattered punctures; hind femora with eight teeth, the three apical teeth close and smaller, the posterior one well removed from the others; abdomen shining, the apical segment with large, irregular setigerous punctures. Black; a yellowish spot on venter; four

anterior knees and all the tarsi yellowish-brown; wings hyaline; marginal and stigmatical veins black; a brown spot basad of stigma.

Male.—Length 4.25 mm. Except for usual differences, like female. Venter without yellow.

Type-locality.—Syracuse, New York. Described from two females and five males reared from *Hicoria glabra* by M. W. Blackman and H. H. Stage and under their numbers H-171 (type), H-114 (allotype), H-955, H-134, H-892, H-1367 and H-212.

Type.—Cat. No. 22093, U. S. Nat. Mus.

Ecphylus hicoriæ, new species.

Readily distinguished from related American species by its colour and sculpture.

Female.—Length to apex of abdomen 3 mm.; length of ovipositor 2.5 mm. Face granular and with irregular transverse, raised lines; frons and vertex with distinct transverse striæ; posterior orbits smooth; postocellar line about half as long as ocellocular line; antennæ 27-jointed, the third joint distinctly shorter than the fourth; pronotum with lateral angles prominent; prescutum punctured, and with a median impressed longitudinal line; notauli foveolate; scutellum without sculpture; propodeum coriaceous, reticulate in apical dorsal middle, a faint dorsal median longitudinal carina and a transverse carina at top of posterior aspect; recurrent interstitial with intercubitus; first tergite one-fourth longer than apical width, with distinct longitudinal striæ, these more prominent laterally so there is a triangularly-shaped median area which is not so coarsely striate, remaining abdominal segments smooth, polished. Black; abdomen beyond first segment rufous; basal joints of antennæ and legs yellowish-ferruginous; pronotum anteriorly and lower part of mesepisternum rufous (may not be constant); wings hyaline; venation dark brown.

Male.—Length 3 mm. Agrees with female except for usual differences.

Type-locality.—Syracuse, New York. Described from three females and one male reared from *Hicoria glabra* by M. W. Blackman and H. H. Stage, and recorded under their numbers H-972 (type , H-956, H-947 and H-118a allotype).

Type.—Cat. No. 22030, U. S. Nat. Mus.

In the male and in one female the frons are partly ferruginous.

Heterospilus blackmanni, new species.

Because of the colour and length of ovipositor this new species would be grouped with *consimilis* Ashmead, but the sculpture is quite different from that species.

Female.—Length to apex of abdomen 2.55; length of ovipositor 2.5 mm.; length of abdomen 1.25 mm. Head smooth, polished; ocelli in nearly an equilateral triangle; inner margins of eyes parallel, the distance between them somewhat greater than their length; antennæ, 20-jointed, the third joint about one-fifth longer than the fourth; scutum and prescutum shining, practically without sculpture; notauli well defined, not foveolate; suture in front of scutellum finely foveolate; scutellum smooth, shining; dorsal lateral areas of the propodeum polished, median carina distinct; posterior face of propodeum finely coriaceous; first tergite about one-sixth longer than apical width, with distinct longitudinal

striæ; base of the second tergite longitudinally aciculate; most of the second and all of the remaining tergites smooth, polished; mesepisternum smooth; sides of the propodeum sculptured like the posterior face; second abcissa shorter than the first intercubitus; recurrent slightly beyond the intercubitus. Black; mandibles, three basal joints of antennæ and the legs yellow; wings hyaline, venation pale brown, stigma somewhat darker.

Male.—Length 2 mm. Agrees well with female except the second tergite is yellowish.

Type-locality.—Syracuse, New York. Described from five females and one male collected by M. W. Blackman and H. H. Stage from *Hicoria glabra*, and recorded under their numbers H-107 (1 type), H-608, H-1141, H-118 and H-608a (allotype).

Type.—Cat. No. 22031, U. S. Nat. Mus.

NEW NEARCTIC CRANE-FLIES (RHYPHIDÆ AND TIPULIDÆ, DIPTERA) PART VII.

BY CHARLES P. ALEXANDER, STATE LABORATORY OF NATURAL HISTORY, URBANA, ILLINOIS.

FAMILY *Rhyphidæ*.

Trichocera colei, new species.

Thoracic stripes indistinct; wings light grey, yellowish at the base, a faint brown cloud on *r-m;* male hypopygium conspicuously enlarged.

Male.—Length, including the hypopygium, about 7–7.5 mm.; wing 6 mm.

Rostrum and palpi dark brown. Antennæ of the male setaceous, black. Head dark grey.

Mesonotum brownish grey without distinct stripes, the posterior half of the scutellum yellowish; postnotum dark. Pleura dark brown, sparsely grey pruinose. Halteres pale, the knobs dark. Legs light brown, the coxæ, trochanters and bases of the femora paler. Wings with a faint grey tinge, the base of the wing yellowish; stigma brown, diffuse; a brownish cloud on *r-m*. Venation: *Sc* ending slightly before *r; R*$_{2+3}$ a very little longer than *R*$_2$ before *r*.

Abdomen dark brown, the incisures paler. Male hypopygium conspicuous, very large for this genus of flies. Pleurites with a group of setæ near the distal end on the inner face. Pleural appendage longer than the pleurite, at the apex enlarged into a blackened lobe which is densely covered with short, erect, yellowish hairs; on the dorsal inner face near the base of this lobe, a slender cylindrical arm. Penis-guard broad at the base, rapidly narrowed to the blunt tip. Gonapophyses in the form of two strongly divergent chitinized horns.

Habitat.—Oregon.

Holotype.—♂, Forest Grove, Washington Co., November 11, 1918, (F. R. Cole). Type in the collection of the author. Paratype.—♂, Vancouver, Washington, Dec. 12, 1918, (Wm. Giles); reared from turnips. In the collection of the U. S. National Museum, Chittenden, No. 2772.

The conspicuous male hypopygium will easily separate the fly from any of the known American species. The species is dedicated to Mr. Frank R. Cole to whom I am indebted for many favours.

June, 1919

FAMILY *Tipulidæ*.

Gonomyia (Gonomyia) mainensis, new species.

Related to *G. subcinerea* O. S.; thoracic pleura striped; abdominal tergites dark brown; male hypopygium with the outer pleural lobe rather short with its apex obliquely truncated; inner lobe bifid, with a posterior flattened blade.

Male.—Length about 5 mm.; wing 5.6 mm.

Head dark, discoloured in the type. Antenna broken.

Pronotum clear light yellow. Mesonotal præscutum pale brown, with three indistinct, dark brown stripes, the lateral margins light coloured; scutum pale brown, the lobes dark; remainder of the mesonotum brown. Pleura light yellow with two distinct, purplish brown stripes, the ventral stripe occupying the mesosternum. Halteres very long and slender, pale, the knobs darkened. Legs with the coxæ dull brownish yellow, darkened on the base of the outer face; remainder of the legs light brown, the tarsi darker. Wings with a faint greyish tinge; stigma darker; veins dark brown. Venation: *Sc* rather long, ending opposite about one-third the length of the radial sector; *Rs* very long, straight; R_{2+3} very long, R_2 correspondingly shortened; deflection of R_{4+5} punctiform; cell *1st* M_2 with the inner end slightly narrowed; basal deflection of Cu_1 beyond the fork of *M*.

Abdomen dark brown, the hypopygium yellowish. Male hypopygium with the outer pleural lobe stout, hairy, slightly darkened toward the apex, which is obliquely truncated and produced inwardly into a small tooth; inner appendage bifid, consisting of a posterior flattened blade terminating in a hook, with a single seta on its face; ventral lobe short, terminating in about two stiff setæ. Gonapophyses small, curved, strongly chitinized, in the unique type unequal.

Habitat.—Maine.

Holotype.—♂, Fort Kent, Aroostook Co., August 29, 1913. Type in the collection of the author.

Gonomyia mainensis differs conspicuously from *G. subcinerea* in its striped pleura, venation, and, especially, the very different structure of the male hypopygium.

Limnophila (Ephelia) angustior, new species.

Wings narrow, the brown markings confined to the vicinity of the veins; pleurites of the male hypopygium with a tuft of long, yellow hairs at the apex; outer pleural appendage with a prominent lateral tooth on the outer margin.

Male.—Length 6.5 mm.; wing 7.5–7.6 mm.

Female.—Length 8–8.4 mm.; wing 8.3 mm.

Similar to *L. superlineata* Doane, differing as follows:

Antennæ dark brown throughout. Mesonotal præscutum without a lateral brown line, the lateral stripes less distinct, the median stripe entire Wings very narrow, strikingly different from those of either *L. superlineata* or *L. aprilina*. Wings light grey with a dark brown and greyish brown pattern, the costal markings relatively small, much narrower than the interspaces; the markings on the disk take the form of narrow seams along the veins and cross-veins; veins dark brown, *Sc* and *R* more yellowish. Venation: the supernumerary cross-vein in cell *M* is inserted so that it lies beyond the end of the

2nd anal vein; the wing pattern is not so heavy as in *L. aprilina*. Male hypopygium with the pleurites moderately elongated, covered with numerous setæ that become very numerous along the basal inner two-thirds; outer apical angle of the pleurite a little produced and blackened, provided with a loose tuft of long, yellow hairs that exceed the pleural appendages in length. Outer pleural appendage slender, with a prominent tooth before the apex on the outer margin, distad of this with numerous appressed teeth and a small, stout apical spine. Inner pleural appendage fleshy, stout, blunt at the tip.

Habitat.—Colorado.

Holotype.—♂, Platte Cañon, Jefferson Co., altitude 10,000 feet, June 27, 1915, (E. J. Oslar).

Allotopotype.—♀.

Paratopotypes.—11 ♂ ♀.

Type in the collection of the author.

Limnophila (Ephelia) apiculata, new species.

Closest to *L. angustior;* pleurites of the male hypopygium without an apical tuft of hairs; outer pleural appendage straight, without a prominent lateral tooth on the outer margin.

Male.—Length, about 6.8 mm.; wing 7.2 mm.

Very similar to *L. angustior*, differing as follows:

Antennal flagellum with the basal segments light brownish yellow, passing into darker brown on the terminal segments. Mesonotum light grey with four dark brown stripes, the intermediate pair very long and separated by a capillary vitta of the ground colour. Dark tips to the femora and tibiæ less distinct. Wings slightly more yellowish, the brown pattern heavier but confined to the vicinity of the veins. Abdomen dull brownish yellow, with an indistinct, dark brown dorso-median stripe. Hypopygium more reddish. Pleurites moderately stout, without a conspicuous apical tuft of long yellowish hairs. Outer pleural appendage black, stout, the apical third along the outer margin with numerous, acute, appressed teeth, the terminal one extended into a free spine. Inner pleural appendage fleshy, pale, covered with numerous stout setæ, the apex narrowed and tipped with three or four setæ.

Habitat.—California.

Holotype.—♂, Alpine, San Diego Co., April 8, 1915, (M. C. Van Duzee).

Paratopotype.—♂.

Type in the collection of the author.

Limnophila (Ephelia) edentata, new species.

Closest to *L. superlineata* Doane; size small, wing of the male about 6.5 mm.; first segment of the antennal flagellum yellowish; wings with a heavy brown pattern, the outer four costal blotches confluent in pairs; outer pleural appendage of the male hypopygium without appressed lateral teeth on the outer margin near the apex.

Male.—Length 5.6 mm.; wing 6.5 mm.

Similar to *L. superlineata* Doane but differing in numerous regards: Size very small. First flagellar segment of the antennæ yellow, the remaining flagellar segments light brown. The median præscutal stripe is widely divided for its entire length; in addition to the narrow lateral stripes and a dark spot

at the margin of the sclerite, there is a small, brown line between the lateral and intermediate stripes that crosses the suture onto the scutal lobes. The femoral tips are broadly dark brown, but the tibial tips are but narrowly and indistinctly darkened. The wings are narrower with a much heavier pattern, the markings at *Sc*1 and *R*1, and at *R*2 and R3 being confluent behind; a few brown dots in the costal and subcostal cells between the larger blotches; petiole of cell *M*1 a little longer than this cell. Male hypopygium with the pleurites rather slender. Outer pleural appendage blackened, terminating in a long, curved hook whose outer margin is not minutely tooth as in many species of the subgenus; on the outer face before the tip with a stout spine; a small, blackened tubercule on the inner margin near the base of the appendage. Inner pleural appendage stout and broad, flattened, covered with numerous setæ.

Habitat.—California.

Holotype.—♂, Apline, San Diego Co., April 9, 1915, (M. C. Van Duzee).

Type in the collection of the author.

Eriocera saturata, new species.

Antennæ black, the scapal segments brighter; præscutum yellowish gray with four dark brown stripes, the intermediate pair narrow; wings reddish brown; cell *M*1 lacking; abdomen dark brown, the lateral margins broadly yellowish.

Female.—Length 13.5 mm.; wing 9.4 mm.

Rostrum short, light brown. Palpi black, the basal segments more brownish. Antennæ with the scapal segments yellowish brown above, reddish beneath; flagellum black. Head broad, brown, with an indistinct darker median area. Frontal tubercle dark brown.

Mesonotal præscutum yellowish gray with four dark brown stripes, the intermediate stripes very narrow, separated from one another by a distance a little less than the diameter of one; anterior portion of the scutal lobes dark; scutellum grey, with the extreme base darkened; postnotum grey. Pleura clear silvery grey, the dorsal pleural region dark brown. Halteres short, brownish yellow, the knobs dark brown. Legs with the coxæ pale brown, sparsely grey pruinose; trochanters brownish yellow; femora brownish yellow, narrowly darker at the tips; tibiæ and tarsi brown. Wings with a strong reddish brown suffusion, the colour being a little darker than in *E. californica* O. S.; a small, brown cloud on *r-m;* veins *Sc* and *R* brown, remaining veins dark brownish black; stigma indistinct. Venation: Cell *M*1 lacking; vein *M*1+2 beyond cell *1st M*2 longer than this cell.

Abdominal tergites dark brown, the lateral margins broadly yellowish. Ovipositor rusty red; sternites light brown, margined laterally with yellow.

Habitat.—California.

Holotype.—♀, Fallbrook, San Diego Co., August 2, 1917, (E. G. Holt).

Type in the United States Biological Survey collection.

E. saturata is closest to *E. velveta* Doane from which it may be told by its deep, saturated reddish brown wings with the stigma not darkened, the greater length of the veins issuing from cell *1st M*2, the colour of the abdomen and other characters.

Tricyphona macateei, new species.

Antennæ black; mesonotum yellowish grey, the præscutum with three stripes of which the median one is divided by a capillary pale line; wings nearly hyaline with a heavy dark brown and grey pattern, the mark at the origin of the sector running into the costal cell; abdominal segments indistinctly banded with yellowish.

Male.—Length 8–8.5 mm.; wing 7.8–8.6 mm.

Rostrum and palpi dark brownish black. Antennæ dark brownish black throughout, the intermediate flagellar segments short-cylindrical or almost rounded, the terminal segments smaller. Eyes broadly contiguous beneath, widely separated above. Head small, dark grey.

Mesonotal præscutum light yellowish gray, with three brown stripes, the median stripe more or less distinctly divided by a ground vitta, this pale stripe clearer behind; scutal lobes dark. Pleura gray with indistinct blotches of darker Halteres short, pale brown, the knobs dark brown. Legs with the coxæ dull yellow, the middle and posterior coxæ sparsely grey pruinose; trochanters dull yellow; femora brownish yellow, the tips broadly dark brown; tibiæ and tarsi dark brown. Wings almost hyaline with a heavy dark brown and grey pattern, this including about six larger markings along the costal margin, the first surrounding the humeral cross-vein, the second Sc_2, the third the origin of the sector, passing into the costal ceil, the fourth mark at the tip of Sc_1; small, pale seams along the margin of the wing at the ends of the veins; narrow seams along the cord and *m*. Venation: Sc_2 about midlength between *h* and the origin of the sector; *Rs* very strongly arcuated at origin; cell M_1 shallow, its petiole longer than *m*; *m-cu* obliterated by the punctiform contact of Cu_1 and *M*.

Abdominal tergites indistinctly banded with dark brown and paler yellowish brown; sternites brown, the posterior half of each of the intermediate segments yellow. The male hypopygium shows the moderately powerful pleurites inclined toward one another so that the tips are contiguous, the apices with abundant blackened spicules.

Habitat.—Maryland.

Holotype.—♂, Beltsville, Prince George Co., October 7, 1917, (W. L. McAtee).

Paratopotype.—♂.

Type in the United States Biological Survey collection.

T. macateei is readily separated from *T. vernalis* (O. S.) by the uniformly dark antennæ, the almost hyaline wings with the pattern larger, darker and more clearly defined, the blotch at the origin of the sector including the costal cell, the short cell M_1 with a long petiole and other characters. This very interesting new species is dedicated to its collector, Mr. W. L. McAtee.

Tipula pendulifera, new species.

Belongs to the *cunctans* group; antennal flagellum dark brown; mesonotum light grey, the præscutum with four stripes; wings with a faint yellowish tinge, the stigmal region and wing-base more suffused; abdomen yellowish with a broad, dark brown median stripe; male hypopygium with a long, pendulous lobe at the ventral angle of each pleurite.

Male.—Length 17 mm.; wing 18 mm.

Female.—Length about 20–21 mm.; wing 18.5–19 mm.

Frontal prolongation of the head brownish grey. Palpi dark brown. Antennæ with the scape reddish brown, the flagellar segments uniformly dark brown. Head dark grey.

Mesonotal præscutum light grey with four greyish brown stripes; scutellum and postnotum clear light grey. Pleura heavily greyish white pruinose. Halteres light brown. Legs with the coxæ yellowish, sparsely grey pruinose; trochanters and femora light brown, the latter darkened at the tips; tibiæ yellowish brown, the tips darkened; tarsi brown. Wings with a faint yellow suffusion; base of the wing and the stigmal region yellowish, this latter including the apex of the costal cell, the apex of cell *1st* R_1 and most of cell *2nd* R_2; costal and subcostal cells brownish; veins dark brown. Venation: Petiole of cell M_1 short.

Abdomen yellowish; segment eight and the basal half of nine in the male dark brown; a very distinct, dark brown, median stripe on both the tergites and sternites; on the former it begins at about midlength of the first tergite as a narrow line, gradually widening behind; these stripes are continuous except for narrow yellowish silvery posterior margins to the segments. Male hypopygium with the sclerites fused into an almost continuous ring. Eighth tergite concealed beneath the seventh, except laterally. Ninth tergite extensive, the posterior margin with a broad median notch, the lateral angles subacute, blackened; on either side of the median line is a small obtuse knob; the ventral margin of the ninth tergite bears two median blackened points. Region of the ninth pleurite long and narrow. Outer pleural appendage broad and flattened, pale, very narrow at the base. Inner pleural appendage complicated in structure. At the ventral angle of each pleurite hangs a very long, pendulous lobe, pale, directed ventrad, slightly enlarged distally and here provided with long, coarse hairs; the dorsal end of this appendage is likewise slightly produced. Between these pendulous lobes a flattened, elongate oval disk is visible.

The female is similar to the male, differing in the sexual characters; the dorsal abdominal stripe is narrower and attains the end of the seventh tergite. Ovipositor with the tergal valves straight; sternal valves very short, high, obtusely rounded at their tips, a little more than one-half the length of the tergal valves.

Habitat.—Colorado (Saguache County).

Holotype.—♂, Cochetopa National Forest, Upper Saguache Ranger Station, September 7, 1917, (A. K. Fisher).

Allotopotype.—♀.

Paratopotypes.—3 ♀'s.

Type in the United States Biological Survey collection.

T. pendulifera is a well-defined species, allied to *T. cunctans* and *T. carinata*, from which it is easily told by its larger size, and the conspicuous pendulous lobes of the male hypopygium.

Tipula noveboracensis, new species.

Belongs to the *tricolor* group, closest to *T. caloptera* Lw.; antennal flagellum short, dark brown; wings with cells M_1, M_2, Cu_1 and most of M_3 brown; male

hypopygium with a powerful curved clawlike horn on either side of the median lobe of the ninth tergite.

Male.—Length, 18–22 mm.; wing, 20.5–25.5 mm.

Close to *T. caloptera* Lw., differing as follows:

Antennal flagellum short, darker, almost uniformly dark brown, the first segment a little paler.

Ground colour of the thorax, including the pleura, bright silvery white. Præscutal stripes darker, the lateral stripes more or less confluent anteriorly with the median stripe, the pale ground interspaces indicated near the suture. Wings with the brown markings darker and differently arranged: cell *1st M*$_2$ and the apical two-thirds of *R*$_5$ hyaline, cells *M*$_1$, *M*$_2$, *Cu*$_1$ and all but the extreme base of *M*$_3$ brown; in *T. caloptera* the white area includes the basal half of cell *1st M*$_2$, the bases of cells *M*$_1$, *M*$_2$ and M$_3$ and the apical half of cell *R*$_5$; the brown in the base of cell *M* is about equally extensive in the two species.

The abdominal pattern is more contrasted than in *T. caloptera*, the broad, lateral stripe being almost black; in the holotype, the ground colour of the tergites is yellowish on the first two segments only, on the remaining segments passing into grey; in the paratypes, however, the bright yellow colour persists to the fifth or sixth segments; in all cases the black, lateral stripes are narrowly connected across the caudal ends of the segments; the lateral margins of the tergites are broadly silvery, more buffy near the end of the abdomen. Male hypopygium conspicuously different from the other members of the *tricolor* group, the narrow, rectangular, somewhat depressed, median lobe with parallel sides being subtended on either side by a powerful, slightly curved clawlike horn which is sometimes slightly roughened.

Habitat.—Northeastern North America.

Holotype.—♂, Power-house Creek, near Gloversville, Fulton Co., New York, altitude 1,000 feet, June 24, 1916, (C. P. Alexander).

Paratopotypes, 2 ♂'s; *paratypes*, ♂, Ithaca, Thompkins Co., New York, May 12, 1915, (C. P. Alexander); ♂, May 24, 1898, pinned with the cast pupal skin; ♂'s, Beaver Dam, New Brunswick, June 23, 1914, (J. D. Tothill).

Type in the collection of the author.

The type and paratopotypes were found resting on small boulders projecting from the bed of a small mountain stream. The flight of these large, beautiful crane-flies is unusually vigorous for a member of this family.

Tipula calopteroides, new species.

Belongs to the *tricolor* group, closest to *T. caloptera* Lw.; antennal flagellum long, clearly bicolorous; mesonotal præscutum with the stripes dull grey, not distinctly margined with darker; wings with the base of cell *M* clear.

Female.—Length about 25 mm.; wing 25.3 mm.

Close to *Tipula caloptera* Lw., differing as follows:

Antennæ longer, distinctly bicolorous, the basal enlargement of the flagellar segments dark brown, remainder of the segments yellowish.

Mesonotal prescutal stripes dull grey, very indistinct, the usual dark margins scarcely evident; the brown median vitta very distinct. Wings with considerably more pale markings than in *T. caloptera*, more nearly approaching the type of *T. strepens;* the brown in the base of cell *M* practically lacking

excepting the usual broad brown seam along *Cu* and its branches; the pale pattern includes the base of cell *1st* M_2, apical two-thirds of cell R_5, base of cells M_1, M_2 and M_3, and the centre of cell Cu_1.

Abdominal tergites with the dark brown lateral stripes very broad, about as wide as the yellow mid-dorsal area, this latter most distinct on tergites one to seven.

Habitat.—North Carolina.

Holotype.—♀, Canton, Haywood Co., June, 1911.

Type in the collection of the author.

Tipula manahatta, new species.

Belongs to the *tricolor* group, closest to *T. sackeniana* Alex.; antennal flagellum light yellow throughout; mesonotum reddish brown with indistinct præscutal stripes; wings with a strong fulvous tinge with scarcely any pale areas on the membrane; abdomen reddish brown without darker stripes.

Male.—Length about 15 mm.; wing 15 mm.

Frontal prolongation of the head light yellowish on the sides, darker above, indistinctly lined with brown; palpi short, brown, the basal segments more yellowish. Antennæ moderately elongated, the scapal segments brown, the flagellar segments light yellowish throughout, the terminal segment brown. Vertex dark grey; occiput and a very narrow margin around the eye paler.

Mesonotum reddish brown, the præscutal stripes very indistinct; scutellum yellow. Pleura yellowish, the mesopleuræ faintly grey pruinose. Halteres dark brown, yellowish at the extreme base. Legs with the coxæ yellowish, faintly pruinose; trochanters yellow; femora and tibiæ reddish brown throughout; tarsi dark brown. Wings with a strong greyish fulvous tinge, the costal margin and a broad seam along *Cu* very broad, rich fulvous; there are scarcely any paler areas on the membrane, the obliterative streak extending about to mid-length of cell M_4; cell R_5, and the bases of the anal cells a little pale.

Abdomen reddish brown, the sides of the first segment more yellowish; abdominal tergites very narrowly and indistinctly ringed caudally with silvery. Male hypopygium as in the *tricolor* group, the sclerites of the ninth segment fused into a continuous compressed ring. Ninth tergite with the median lobe, prominent, depressed, slightly expanded distally, reddish, the extreme posterior margin minutely spiculose; margin of the sclerites between the tergal and pleural regions light yellowish. Outer pleural appendage large, fleshy, distinctly notched at its apex, covered with short dense hairs. Inner pleural appendage subchitinized, flattened, with a deep split that separates off a posterior hook or lobule whose posterior margin is grooved longitudinally into a scrobe; posterior margin of the anterior appendage with a high, flattened carina; apex broadly rounded. At the base and ventrad of the pleural appendage is a triangular lobe which is densely covered with a short, golden yellow pubescence and, ventrally, a number of long reddish hairs. Region of the ninth sternite extensive, the adjacent margins almost continuous, from between them projecting the straight, slender penis-guard and two small oval, flattened lobes.

Habitat.—New York (Suffolk County).

Holotype.—♂, Yaphank, Long Island, September 3–4, (Charles Schaeffer).

Paratopotype.—♂.

Type in the collection of the Brooklyn Museum.

Tipula phoroctenia, new species.

Belongs to the *marmorata* group, closest to *T. fragilis* Lw.; male hypopygium with the ninth tergite having a broad V-shaped notch; outer pleural appendage without a basal tooth; eighth sternite strongly projecting, shovel-like, the posterior margin shallowly notched and with a row of black, comb-like spines.

Male.—Length about 13 mm., wing 14 mm.

Similar to *T. fragilis* Lw. in most respects, differing as follows: The præscutal stripes are broader and less distinct, the intermediate pair extending a little farther cephalad, the grey thoracic interspaces narrower. The wings are a little narrower, with the dark pattern less distinct. The abdomen is light yellow with a narrow, dark brown sublateral stripe and silvery grey lateral margins. The ninth tergite and the sixth to ninth sternites are dark brown. The most conspicuous differences are to be found in the structure of the male hypopygium, the ninth tergite of which has a broad, posterior V-shaped notch the caudal margin blackened, with the lobes running out into slender, chitinized points, the space between with a few smaller elevations; lateral notches extensive, not so deep as in *T. fragilis*. Outer pleural appendage long, slender, somewhat flattened, without a distinct chitinized basal ridge or tooth as in most other species of the group. The fleshy lobes that arise near the ventral angle of the pleurites are very large so that they practically fill this portion of the opening of the genital chamber; they are pale reddish, covered with a short, dense pale pubescence. Ninth sternite with a broad square notch, from the base of which projects a stout, reddish rod, presumably the penis-guard. Eighth sternite extensive, projecting, the posterior margin nearly truncated with a very shallow notch, set with a row of short, black spinous teeth; extreme posterior lateral angles of the sternite with a few long yellowish hairs.

Habitat.—Maine.

Holotype.—♂, Orono, Penobscot Co., in a bog at the edge of a wood, October 3, 1913, (H. M. Parshley).

Paratopotype.—♂, indoors, October 16, 1913.

Type in the collection of the author.

Tipula nebulipennis, new species.

Belongs to the *marmorata* group, closest to *T. fragilis* Lw.; legs mostly brown with only the femoral bases yellowish; male hypopygium having the caudal margin of the ninth tergite with two flattened divergent lobes separated from one another by a very small notch; outer pleural appendage with a subacute shiny chitinized tooth; eighth sternite slighlty projecting, the posterior margin with a broad, U-shaped median notch.

Male.—Length 12–13 mm.; wing, 12.2–13.5 mm.

Frontal prolongation of the head dark grey, the sides more brownish. palpi short, brownish black. Antennæ with the scape yellow, the flagellum brownish black; flagellar segments only slightly enlarged basally. Head grey.

Mesonotal præscutum light grey with four brown stripes, the intermediate pair becoming indistinct anterior to the level of the pseudosutural foveæ; scutal lobes largely brown; scutellum and postnotum light grey. Pleura grey, clearer and lighter posteriorly. Halteres brown, the extreme base yellow. Legs with the coxæ light grey; trochanters light yellow; femora yellowish basally, soon passing into brown, the tip narrowly darker brown; tibiæ with the basal half light brown, the apical half darker brown; tarsi dark brown. Wing pattern and venation about as in *T. fragilis*, the stigma paler brown.

Abdomen with the first tergite grey pruinose, the other tergites brown with a broad, dark brown sublateral stripe, ringed posteriorly with yellowish, these rings broadest on the basal segments, becoming indistinct about the seventh segment; sternites one to five bright yellow, the basal segments a little darker laterally; remaining sternites dark brown. Male hypopygium with the ninth tergite rather large, divided into two apparent halves by a mid-dorsal impression; each half is produced caudad into an inner flattened lobe, separated from its mate of the opposite side by a very small and narrow notch, the lateral angle of each lobe slightly produced and with a few stout black setæ; the tergite is dark, the lateral margins yellowish, the apical lobes orange yellow and provided with a short, dense pubescence. Outer pleural appendage large, greyish, slightly curved, the outer face with appressed black hairs; near the base of the appendage a shiny, flattened, chitinized tooth. Inner pleural appendage compressed, flattened, extensive, near its base forming a cup-like hollow. An enlarged, dark-coloured, fleshy lobe provided with numerous pale hairs lies on either side near the ventral angle of the pleurite, extending dorsad along the opening of the genital chamber; the outer basal margin of this lobe is light yellow in colour. Eighth sternite slightly projecting, the posterior margin with a large, shallow, broadly U-shaped notch, the lateral angles of which are provided with long whitish hairs, the outer basal margin of this lobe minutely spinulose, light yellow beneath.

Habitat.—Labrador.

Holotype.—♂, Battle Harbour, August 1, 1912, (G. P. Engelhardt).

Paratopotype.—♂.

Type in the collection of the Brooklyn Museum.

Tipula fragilina, new species.

Belongs to the *marmorata* group, closest to *T. fragilis* Lw.; legs darkened, the femora with a broad, yellowish subterminal ring before the black tip; male hypopygium having the ninth tergite with a wide V-shaped notch; outer pleural appendage with a blunt, blackened basal lobe; eighth sternite carinate, the posterior margin with a very deep and narrow median notch, the margins contiguous or nearly so and provided with long, yellowish hairs.

Male.—Length about 13 mm.; wing 13.3 mm.

Female.—Length about 13 mm.; wing 13 mm.

Generally similar to *T. fragilis* Lw., differing as follows: The intermediate stripes of the præscutum are broader and extend further cephalad; the ground colour between the intermediate and lateral stripes narrower. Pruinosity of the pleura darker. Legs darker, the black femoral tips broader and with a

distinct yellow subterminal ring. Hypopygium darker coloured. The most striking differences between this and the related regional species are found in the male hypopygium, as follows:

Ninth tergite dark coloured, with a deep, impressed mid-dorsal line; posterior margin with a wide V-shaped notch, the lateral lobes formed terminating in blackened chitinized points, the lateral notches only slightly concave, larger and not so deeply rounded as in *T. fragilis*. Outer pleural appendage long, slightly flattened, not as stout as usual in the group, pale, almost white in colour, the basal third slightly contracted and produced proximad into a blunt, blackened lobe. Inner pleural appendage a pale, almost white, compressed blade, on the posterior margin near the base bearing a small knob provided with numerous short, black setæ. At the ventral angle of the pleurite, jutting dorsad across the face of the genital chamber as a long, slender, slightly sinuous lobe tapering to a point, densely covered with white hairs; this structure is considerably larger than the corresponding one in *T. fragilis*. Ninth sternite with a deep notch which is slightly enlarged at its base, the sides parallel or nearly so. Eighth sternite compressed, with a very deep median notch, the adjacent lobes contiguous apically, though separated basally, provided with long, yellow hairs. In *T. fragilis*, the eighth sternite is spade-shaped, unnotched.

Habitat.—Alaska. (Iditarod River Country).

Holotype.—♂, Flat, September 6, 1917, (A. N. Twitchell).

Allotype.—♀, Bethel, September 24, 1917, (A. N. Twitchell).

Type in the United States Biological Survey collection.

Nephrotoma euceroides, new species.

Generally similar to *N. eucera* (Lw.) from which it differs as follows: Average size much smaller (male, length 14–14.2 mm.; wing 13.8–15 mm.). Male antennæ with only 17 evident segments. Thoracic stripes distinct, reddish brown, much darker than in *N. eucera*. Wings with a more greyish yellow tinge, the stigma poorly defined, pale. Abdomen darker, brownish yellow, the hypopygium brown. Male hypopygium with the ninth tergite having the caudal margin evenly rounded with a small, narrow median notch whose nearly contiguous lateral angles are produced beneath into blackened lobes which are densely spiculose. Eighth sternite with a broad, deep posterior notch, the median area of the sternite not so densely hairy as in *N. eucera*.

Habitat.—Northeastern North America.

Holotype.—♂, Sport Island, Fulton Co., New York, altitude 750 feet. June 16, 1910, (C. P. Alexander).

Paratype.—♂, Perth, New Brunswick, June 15, 1915, (F. M. McKenzie).

In general appearance, *N. euceroides* is very similar to *N. breviorcornis* (Doane) from which it is most easily told by the number and structure of the antennal segments.

Mailed July 8th, 1919